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"THE ENGINEER," JUNE 24, 1932.

With METALLURGICAL SUPPLEMENT.

# The Engineer.

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VOL. CLIII.—No. 3989] LONDON: FRIDAY EVENING, JUNE 24, 1932 [PRICE { WITH SUPPLEMENT } ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES.

## Northampton Polytechnic INSTITUTE.

ST. JOHN-STREET, LONDON, E.C. 1.

FULL-TIME COURSES in ENGINEERING are provided as follows :—

MECHANICAL,
CIVIL,
AERONAUTICAL,
ELECTRICAL, and
ELECTRICAL COMMUNICATION.

Courses extend over four years and include two periods, each of five months, in industrial employment.

The Polytechnic is an Institution of the University of London, and courses are arranged to prepare Matriculated Students for the B.Sc. (Engineering) Degree of the University.

Entrance examination : Wednesday and Thursday, July 13th and 14th, 1932.

For prospectus apply to the PRINCIPAL. 8677

## Barrow-in-Furness Education COMMITTEE.

TECHNICAL COLLEGE AND JUNIOR TECHNICAL SCHOOL.

WANTED, for September, SENIOR ASSISTANT to the PRINCIPAL, to teach subjects in (a) the Evening Technical College in MECHANICAL ENGINEERING to Advanced National Certificate Standard ; (b) the Junior Technical School. Applicants must be graduates with high qualifications in engineering. Workshop experience essential. Burnham Scale for Technical Teachers plus £30 (less 10 per cent.).

Particulars and duties and form of application may be had from the undersigned (on receipt of a stamped and addressed foolscap envelope), to whom all applications should be returned not later than 2nd July.

J. H. WILLIS,
Director of Education.

Town Hall, Barrow-in-Furness. 8671

## County Borough of Swansea.

MAIN DRAINAGE SCHEME.
CONTRACT No. 9.

| Yds. | Dia. | Description. |
|---|---|---|
| | | SECTION A (BRYNMILL TO HAFOD) ..... 4,111 |
| | | " B (HAFOD TO MORRISTON).... 4,902 |
| | | " C (MORRISTON TO CLYDACH) 3,202 |
| | | 12,215 |
| | | WORKS FROM BRYNMILL TO CLYDACH. (UNEMPLOYMENT RELIEF WORKS.) |

The Corporation invite TENDERS for the CONSTRUCTION of approximately 7 Miles of MAIN TRUNK SEWER (principally in Brick and Concrete), of which about 5 Miles will be in TUNNEL and 2 Miles in OPEN CUTTING ; together with Storm Water Drains, Culverts, Manholes, Overflows, Chambers, Stream Diversion, and other incidental works, as briefly stated below :—

| Yds. | Dia. | Description. |
|---|---|---|
| | | SECTION A, B, AND C. |
| | | SECTION A. |
| 506 .. | 5ft. 6in. .. | Cast Iron Pipe Sewer in trench haunched in concrete |
| 822 .. | 5ft. 3in. .. | Brick and Concrete Sewer in trench |
| 184 .. | 5ft. 3in. .. | Ditto. Ditto. |
| 1094 .. | 5ft. 3in. .. | Ditto. in TUNNEL |
| 1168 .. | 4ft. 0in. .. | Ditto. Ditto. |
| 98 .. | 4ft. 6in. .. | Ditto. Ditto. |
| 323 .. | 4ft. 0in. .. | Ditto. Ditto. |
| 4111 | | |
| | | also |
| 480 .. | 1ft. 6in. .. | Concrete pipe S.W.D. bedded on concrete |
| 480 .. | 2ft. 6in. .. | Ditto, surrounded with concrete |
| 30 .. | 2ft. 3in. .. | Ditto. Ditto. |
| 5111 .. | 41 No. .. | Brick Manholes and Overflow Chambers, and various incidental works |
| | | SECTION B. |
| 3800 .. | 3ft. 6in. .. | Brick and Concrete Sewer in TUNNEL |
| 1053 .. | 3ft. 0in. .. | Ditto. Ditto. |
| 100 .. | 5ft. 0in. .. | Brick and Concrete Culvert, Stream Diversion in TUNNEL |
| 17 .. | 1ft. 9in. .. | Cast Iron Pipe Sewer in Concrete in TUNNEL |
| 32 .. | 3ft. by 2ft. .. | Brick and Concrete Sewer in TUNNEL |
| 33 .. | 1ft. 6in. .. | Cast Iron Pipe S.W.O. Culvert in TUNNEL |
| 5035 .. | 44 No. .. | Brick Manholes and Overflow Chambers and various incidental works |
| | | SECTION C. |
| 1614 .. | 2ft. 3in. .. | Brick and Concrete Sewer in trench |
| 496 .. | 2ft. 3in. .. | Ditto, in TUNNEL |
| 278 .. | 2ft. 3in. .. | Cast Iron Pipe Sewer in trench |
| 191 .. | 2ft. 0in. .. | Brick and Concrete Sewer in trench |
| 628 .. | 2ft. 0in. .. | Ditto, in TUNNEL |
| 40 .. | 1ft. 3in. .. | Concrete Pipe S.W.O. Culvert in TUNNEL |
| 3242 .. | 29 No. .. | Brick Manholes and Overflow Chambers and various incidental works |

The Contractor shall submit SEPARATE TENDERS for one or more of the SECTIONS A, B, and C, comprised in Contract No. 9.

The Corporation in their absolute discretion may accept :—

(a) One Tender comprising the three Sections A, B, and C, or, alternatively,

(b) A combination of any two Tenders of any one Contractor for any two Sections, or, alternatively,

(c) A Tender of any Contractor for any one Section.

The whole of the works are UNEMPLOYMENT RELIEF WORKS, and will be subject to certain conditions laid down by the Government Unemployment Grants Committee.

On and after the 15th June, 1932, plans may be seen and specification, form of Tender, bills of quantities, and set of selected drawings obtained at the office of the Chief Engineer, Mr. J. Richard Heath, Guildhall, Swansea, on deposit of Twenty Pounds, which will be returned on receipt of a bona fide Tender (not subsequently withdrawn), together with the specification, bills of quantities and set of drawings, all of which documents are the property of the Corporation, to whom they shall be returned on demand.

NOTE.—Only a limited number of sets of drawings are available, and Contractors should therefore make early application for same.

The documents and Tenders, which shall be enclosed in a sealed registered envelope, endorsed "SWANSEA MAIN DRAINAGE, CONTRACT No. 9," must be received by the undersigned not later than Twelve Noon on the 15th July, 1932.

The lowest or any Tender will not necessarily be accepted.

H. L. LANG-COATH,
Town Clerk.

Guildhall,
Swansea,
June, 1932. 8613

## The Engineer

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## Heriot-Watt College, Edinburgh

DEPARTMENTS OF MECHANICAL ENGINEERING AND ELECTRICAL ENGINEERING.

MECHANICAL ENGINEERING :
PROFESSOR A. R. HORNE O.B.E., B.Sc., M.I. Mech. E., A.M.I.C.E.
ELECTRICAL ENGINEERING :
PROFESSOR F. G. BAILY, M.A., M.I.E.E.
FULL-TIME DAY DIPLOMA COURSES leading to professional recognition.
CLASSES COMMENCE 11th OCTOBER.
Full particulars from the College.
J. CAMERON SMAIL, O.B.E., F.R.S.E., Principal.
8690

## Borough of Bangor.

(COUNTY DOWN, IRELAND).
MAIN DRAINAGE.
CONTRACT No. 2.
TO CONTRACTORS.

The Council of the Borough of Bangor invite TENDERS for the CONSTRUCTION of about 2400 YARDS of 15in. CAST IRON PUMPING MAIN and about 2900 YARDS of 24in. and 27in. CONCRETE TUBE SEWERS, together with MANHOLES, VENTILATING SHAFTS, and other APPURTENANT WORKS, all in accordance with plans and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, London, S.W. 1.

Copies of the specification, bill of quantities, and form of Tender may be obtained from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Drawings may be seen at the offices of the Engineer or at the office of the Surveyor, Town Hall, Bangor, Co. Down, Ireland.

The works are for the relief of the unemployed, and the contract will be subject to special conditions laid down by the Ministry of Labour, Northern Ireland, for Public Utility Schemes.

Sealed Tenders, endorsed "Bangor Main Drainage, Contract No. 2," addressed to the undersigned, at his office at Bangor, must be received before Twelve Noon on Monday, the 25th July, 1932.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
R. M. MOORE,
Town Clerk.

Town Hall, Bangor,
Co. Down, Ireland. 8679

PUBLIC NOTICES.

## Leith Dock Commission.

TENDERS
FOR
NEW REINFORCED CONCRETE GRAIN WAREHOUSE.

THE COMMISSIONERS FOR THE HARBOUR AND DOCKS OF LEITH are prepared to receive, from CONTRACTORS WHO HAVE HAD EXPERIENCE IN SIMILAR WORK, TENDERS for the provision and erection of a NEW GRAIN WAREHOUSE AND SILOS of Reinforced Concrete, the building to occupy an area of about 170 feet by 140 feet on ground adjoining the East Quay of the Imperial Dock, Leith, the highest part of the building being about 150 feet above quay level.

On and after 15th June, copies of the Description of Works, Conditions of Contract, Specification, Bill of Quantities, General Drawings, and Forms of Schedule of Prices, and Tender may be obtained from ALFRED H. ROBERTS, Esq., M. Inst. C.E., Superintendent and Engineer, at the address undernoted, on payment of a deposit of Fifteen Pounds. An additional copy of the Specification and Schedules may be obtained upon a further deposit of Two Pounds. These deposits will be returned after the receipt of a bona fide Tender and on the return of all the documents.

The Drawings, showing Steelwork and other details, may, by appointment, be examined at the Engineer's Office here.

The Commissioners do not bind themselves to accept the lowest or any Tender.

Tenders, on the prescribed form, enclosed in sealed envelopes and endorsed on the outside "Tender for Grain Warehouse," must be delivered not later than 30th June, 1932, to the Subscriber.

C. C. LEARMONTH,
Clerk to the Commissioners.

Dock Offices, Leith, Edinburgh, 6,
16th June, 1932. 8633

SITUATIONS OPEN.

ENGINEER REPRESENTATIVE WANTED by Old-established Firm of Laundry Engineers. Must be young and with experience of Laundry Practice. Give particulars of previous experience, age, and salary required.—Box B218, T. E. Browne's Advert. Offices, 163, Queen Victoria-street E.C. 4. 8678 A

PUBLIC NOTICES

## London County Council.

TENDERS are INVITED for the CLEANING and RE-PAINTING of CHELSEA BRIDGE (Part).

Specifications, form of Tender, &c., may be obtained on application to the Chief Engineer, The Old County Hall, Spring-gardens, S.W. 1, upon payment of £1 by crossed cheque or order payable to the London County Council. (NOTE.—CASH WILL NOT BE ACCEPTED.) This amount will be returnable only if a bona fide Tender has been sent in and not subsequently withdrawn. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.

Remittances by post should be addressed to the Chief Engineer, The Old County Hall, Spring-gardens, S.W. 1. Personal enquiries at Room 2, No. 8, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the CLERK of the COUNCIL at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 11th July, 1932, will be considered.

The Council does not bind itself to accept the LOWEST or any Tender. 8675

## St. Neots Urban District COUNCIL.

WATERWORKS.
CONTRACT NO. 2.
FILTRATION, CHLORINATING, AND DE-CHLORINATING PLANT.
TO BRITISH MANUFACTURERS OF WATER TREATMENT PLANT.

The St. Neots Urban District Council is prepared to receive TENDERS for the SUPPLY and ERECTION of a complete WATER TREATMENT PLANT, capable of dealing with water pumped from an adjacent well at the rate of 5000 gallons per hour.

The works included in the contract consist of the installation of pressure sand filters arranged for hydraulically cleansing, automatically operated chlorinating plant and de-chlorinating filter with all pipe connections and accessories in accordance with the drawing, general conditions and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The general conditions, specification, and a copy of the drawing may be obtained by the manufacturer from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Water Treatment Plant," must be delivered at my office at St. Neots before Noon on Friday, the 15th day of July, 1932.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
(Signed) T. SPENCER,
Clerk.

Council Offices,
St. Neots, Hunts. 8666

## St. Neots Urban District COUNCIL.

WATERWORKS.
CONTRACT NO. 1.
ELECTRICALLY DRIVEN PUMPING PLANT.
TO BRITISH MANUFACTURERS OF CENTRIFUGAL PUMPING PLANT.

The St. Neots Urban District Council is prepared to receive TENDERS for the SUPPLY and ERECTION of a VERTICAL-SPINDLE ELECTRICALLY DRIVEN CENTRIFUGAL PUMP for pumping from a well about 20ft. in depth at the rate of about 5000 gallons per hour.

The works included in the contract consist of the installation of the pump, electric motor, automatic starting apparatus, switchboard, pipes, valves, connections, &c., and all accessories in accordance with the drawing, general conditions and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The general conditions, specification and a copy of the drawing may be obtained by the manufacturer from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Pumping Plant," must be delivered at my office at St. Neots before Noon on Friday, the 15th day of July, 1932.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
(Signed) T. SPENCER,
Clerk.

Council Offices,
St. Neots, Hunts. 8665

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# The Engineer

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PARIS: Dunod, 92, Rue Bonaparte
PARIS: W. H. Smith and Son, 248, Rue de Rivoli

GERMANY .. BERLIN - LICHTERFELDE - WEST: H. Hermanns, Dahlemer Strasse, 64 A
LEIPZIG: K. W. Hiersemann, Konigstrasse 29

HOLLAND .. ROTTERDAM: Hector's Boekhandel, Noordblaak 59
ROTTERDAM: Techn. Boekhandel, "Plan C," Gelderschestraat 4

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UNITED STATES OF AMERICA International News Co., 131, Varick-street, New York, N.Y., and all Branches

Entered as second-class matter at the Post Office, New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 397, P.L. & R.)

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*


### "THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

### ADVERTISEMENTS.

**The charge for Classified Advertisements is 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication).**

*Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of* THE ENGINEER.

### THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.


Postal Address, 28, Essex-street, Strand, London, W.C. 2. Teleg. Address, "Engineer Newspaper, Estrand, London." Tel., Central 3565 (8 Lines).


## PUBLIC NOTICES.

### County Borough of SOUTHAMPTON.

APPOINTMENT OF WATERWORKS ENGINEER.

The Corporation invite APPLICATIONS for the POSITION of WATERWORKS ENGINEER and MANAGER of their Waterworks and Water Undertaking, from properly qualified Engineers not exceeding 40 years of age and fully experienced in the design, construction, and maintenance of modern waterworks, and the management of large public water undertakings.

The gentleman appointed will be required to advise the Council upon all matters relating to the water supply of their area of supply, to perform all the duties devolving on him under the Public Health and Local Acts, to devote his whole time to the duties of the office, and to engage in no other business or occupation. He will hold office during the pleasure of the Council. Salary £1100 per annum, subject to temporary abatement (at present £55 per annum). A car allowance of £200 per annum will also be paid.

The Local Government and Other Officers' Superannuation Act, 1922, will be applicable to the appointment and contributions to the Superannuation Fund will be deducted from the salary. The selected candidate will be required to pass a satisfactory medical examination.

Applications, stating previous and present appointments, qualifications and any other relevant particulars, and accompanied by copies of not more than three recent testimonials, and the names and addresses of three referees, must be addressed to the Town Clerk, endorsed "Appointment of Waterworks Engineer" and delivered at the Town Clerk's office on or before 30th June, 1932.

Canvassing is prohibited and will disqualify.

R. RONALD H. MEGGESON,
Town Clerk.

Town Clerk's Office,
Municipal Offices, Southampton,
15th June, 1932. 8667

### County Borough of Swansea.

MAIN DRAINAGE SCHEME.—CONTRACT NO. 9.

APPOINTMENTS OF RESIDENT ENGINEERS AND CLERKS OF WORKS.

The Corporation invite APPLICATIONS for the following TEMPORARY APPOINTMENTS:—

(a) SENIOR RESIDENT ENGINEER; salary at the rate of £700 per annum.
(b) 2 SECTIONAL RESIDENT ENGINEERS; salary at the rate of £400 per annum each.
(c) 3 CLERKS of WORKS; salary at the rate of £7 per week each.

The duration of the works will be for a probable period of two years, and the above appointments will be terminable by one month's notice on either side.

Applicants for the appointment of Senior Resident Engineer must have undergone a regular course of engineering training and be thoroughly experienced in the duties of a Resident Engineer; they must have had specialised experience in large tunnel works through congested areas and under buildings on big drainage schemes, both with and without compressed air, and have an intimate knowledge of the construction of brick and concrete sewers in various strata, including waterlogged headings and trenches.

Applicants for the appointments of Sectional Resident Engineers must have had a good comprehensive experience on the lines indicated above.

Applicants for the appointments of Clerks of Works must be thoroughly experienced Clerks of Works and must have had extensive experience on large main drainage schemes and be fully competent to supervise any of the works described above.

Applications must be made on forms to be obtained from Mr. J. Richard Heath, Chief Engineer, Main Drainage Scheme, Guildhall, Swansea, to whom applications shall be addressed endorsed "Senior Resident Engineer," "Sectional Resident Engineer," or "Clerk of Works," as the case may be, and shall be delivered not later than first post on July 22nd, 1932

H. L. LANG-COATH,
Town Clerk.

Guildhall, Swansea,
June, 1932. 8668

### Metropolitan Borough of POPLAR.

ELECTRICITY DEPARTMENT.

ASSISTANT GENERAL MANAGER AND DEPUTY ENGINEER.

The Council of the Metropolitan Borough of Poplar invite APPLICATIONS from persons fully qualified for the POSITION of ASSISTANT GENERAL MANAGER and DEPUTY ENGINEER in the Electricity Department.

Applicants must have had first-class training and experience in Electricity Supply in all its branches and be capable of taking full control of the Department in the absence of the General Manager and Chief Engineer.

The salary will be at the rate of £900 per annum.

The successful candidate will be required to pass a medical examination and to contribute to the Council's Superannuation Fund.

Forms of application may be obtained from my office and must be returned, together with a letter of application and copies of three recent testimonials, in envelope endorsed "Deputy Engineer," not later than Saturday, 2nd July next.

Canvassing members or officers of the Council in any form will disqualify.

H. E. DENNIS,
Town Clerk.

Council Offices,
117, High-street, Poplar, E. 14.
14th June, 1932. 8641

## SITUATIONS OPEN.

THOROUGHLY Practical or Technical ENGINEER, Executive Position; Hydraulic Experience useful; required for development work. State experience and full details.—Address, 8653, The Engineer Office. 8653 A

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

REQUIRED by Important Firm of Hydraulic Engineers, ENGINEER REPRESENTATIVE, with first-class technical knowledge of Bakelite and Synthetic Resinous Mouldings, with selling ability and live connection amongst users of Moulding Presses for same. State age, qualifications, and salary.—Address, 8676, The Engineer Office. 8676 A

TECHNICAL ASSISTANT, University Engineering degree, 25-30 years of age, REQUIRED by Works Management, Mather and Platt, Ltd., Manchester. Experience in Workshop Administration and Personnel Control essential.—Apply by letter, stating technical qualifications, experience, age, and salary required to "WORKS MANAGER." 8688 A

THOROUGHLY QUALIFIED TECHNICAL ENGINEER, preferably with University Degree, to Take Charge of Experimental Work on Compression Ignition Engines. Must have been engaged on similar work hitherto.—Address, giving full particulars of age, experience and salary required, 8689, The Engineer Office. 8689 A

ENGINEER-DRAUGHTSMAN, Age 21-30, REQUIRED for Commercial and Technical Work. Good general education and experience of Waterworks essential. Good prospects.—Write full particulars 8683, The Engineer Office. 8683 A

REINFORCED CONCRETE DESIGNER and DRAUGHTSMAN REQUIRED Temporarily in North of England. State full particulars of age, experience and salary.—Address, P2546, The Engineer Office. P2546 A

FOREMAN for Small Machine and Erecting Shops, London district; mainly general, with proportion of Precision Work. Previous experience essential; age 35-45. State experience and salary.—Address, P2544, The Engineer Office. P2544 A

## SITUATIONS WANTED.

A CAPABLE ELECTRICAL ENGINEER (28), Grad. I.E.E., SEEKS RESPONSIBLE POST, home or abroad. Technical college trained to B.Sc. standard, A.M.I.E.E. (examination), 11 yrs.' experience steam, electric, H.T. generating and pneumatic plant (erection, operation, maintenance); an able, steady, and conscientious worker of good record.—Address, P2545, The Engineer Office. P2545 B

A HIGHLY QUALIFIED ENGINEER, with both civil and mechanical experience of waterworks, sewage disposal, irrigation, drainage, water power, and harbour works, with knowledge of conditions in India, Africa, and on the Continent, DESIRES an APPOINTMENT, preferably with London headquarters, where his proved initiative and long experience can be fully utilised. Highest credentials given.
Address, P8602, The Engineer Office. P8602 B

AN ENERGETIC MAN, of the Highest Integrity, Age just 40 years, REQUIRES a POSITION OF TRUST.
Keen Buyer, good general engineering and installation draughtsman; ten years' executive experience; six years as chief designer in charge of jig and tool, &c., drawing-office; also four years in the capacity of manager and engineer.
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For continuation of Small Advertisements see page 4.


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# A Seven-Day Journal

## Profit-Sharing in 1931.

A NET decrease of eight schemes is reported by the Ministry of Labour in its profit-sharing and co-partnership statistics for 1931. At the end of the year 493 schemes in all kinds of undertakings were known to have been in operation. There were approximately 477,000 workpeople employed by the firms concerned, and 233,000 were eligible to participate. In the 419 schemes for which certain details are available, a total of 195,400 participating employees received an average bonus of £10 0s. 10d., giving a percentage addition to earnings of 5·3. In businesses other than co-operative societies there were 324 schemes, with 199,100 participants out of 441,300 total employees, in operation at the end of the year. Details are available of 251 schemes, which provided an average bonus of £10 19s. 7d., or 5·4 per cent. addition to wages to 161,400 participants. The firms organising these schemes employed approximately 255,700 workpeople. In the metal, engineering, and shipbuilding group of trades for which details are given, 29 schemes resulted in an average distribution of £3 11s. 10d., or 2·9 per cent. addition to earnings, to the 14,300 employees eligible to participate. In this group 47 schemes were known to have been in operation at the end of the year, the participants numbering 19,400 out of a total of 72,500. The Ministry reports the introduction of one new scheme during the year. It concerned a metal-smelting business, there being approximately 800 workpeople. Under this scheme the employees will receive a percentage on earnings equivalent to the excess above 5 per cent. paid on ordinary share capital. Six schemes, with about 1900 participants, were discontinued during 1931. One scheme was in connection with an ironfounding concern and another with a gas undertaking. The reason for the withdrawal of one scheme is stated to have been amalgamation with another firm; in three others it was due to the economic depression; while dissatisfaction of the employers with the results and the substitution of a system outside the definition of profit-sharing account for the remaining two.

## Obsolete Ships.

ACCORDING to our contemporary, the *Shipping World*, important decisions which may affect the future of merchant shipping were taken at a private conference of the Executive Committee of the Baltic and International Marine Conference, which was held on the German liner "Europa" last week. The chairman was the President of the Conference, Mr. W. A. Soutar, and British shipping was well represented. It was considered that a policy of scrapping the tonnage in excess of trade requirements was more likely to succeed than was a general scheme for the laying-up of such tonnage. The two principal difficulties to be faced in formulating any such scheme were recognised to be the finding of the money to finance the project, and the economical disposal of the very large quantities of scrap metal which would most likely thereby be created. It was proposed that the money should be raised by levying special dues on all shipping, both national and foreign, calling at the ports of the countries concerned, and that if found practicable such dues might be spread over a period of three years, in which case they would be small. The conference considered that it would be necessary to store the scrap material and to release it as required. One advantage of the scrapping scheme discussed would be the relief of unemployment in the shipbuilding industry by employing shipbuilding men on ship-breaking operations; and another would be a putting to an end of the practice of selling obsolete tonnage to countries with a low standard of wages, with as a result the frequent undercutting of freight charges by ships operated by shipowners of such countries.

## The French Line Cabin Ship Champlain.

THE 28,000-ton, 640ft., cabin-class twin-screw liner "Champlain," which left Le Havre at 1 p.m. on Saturday last for Plymouth and New York, marks a distinctive addition to the famous ships of the French Line fleet. Like many of her sisters, she was built and engined at St. Nazaire by the Chantier et Ateliers de St. Nazaire Penhoët. In order to mark her maiden voyage a party of British guests, representing travel, transport, and shipping interests, were invited by the Compagnie Général Transatlantique to accompany the liner from Le Havre to Plymouth, which was reached late on Saturday evening last. The party was welcomed by Director Hermann du Pasquier, of Le Havre. Monsieur P. de Malglaive, assistant general manager, Paris, and Monsieur J. Morin de Linclays, secretary general, Paris, along with Monsieur P. C. Le Brun, and Mr. G. C. Rhodes, directors of the London company. The voyage was a smooth and pleasant one, and the excellent passenger accommodation and effectively decorated public rooms were greatly admired. A pleasing feature of the ship is the generous provision of deck space for all classes. The top sun deck extends from the funnel casing right aft, and is unencumbered by fans and air heating appliances, which are neatly housed in special rooms on either side of the ship forward on a lower deck. The propelling machinery comprises a twin-screw arrangement of 24,000 S.H.P. Parsons three-stage turbines, which take superheated steam from six Penhoët oil-fired water-tube boilers operating at 400 lb. per square inch, and a steam temperature of 662 deg. Fah. The auxiliary generators, three in number, each have a normal output of 900 kV, and were supplied by Allens, of Bedford. They are the largest of their type afloat. An outstanding feature of the new liner is her single streamlined funnel, with a smoke cowl, the object of which is to deflect the smoke and gases from the sun deck. The ship has a designed speed of 20 knots, and during her trials a speed of 21 knots was attained.

## Oil Engines at Bedford.

ON Tuesday last, June 21st, a party was invited by W. H. Allen, Sons and Co., Ltd., to visit the Queen's Engineering Works at Bedford, and to inspect in course of construction and under test a new series of high-speed airless-injection heavy-oil engines which have been designed for rail traction, marine propulsion, and power station work. The party attending the demonstration was received by the chairman of the company, Mr. Richard W. Allen, who was accompanied by his co-directors, Mr. Harold G. Allen and Mr. Rupert S. Allen, and members of the administrative and technical staff. After luncheon the party divided into groups and passing through the various sections of the works met in the oil engine testing department, where several engines were seen running. In all departments we noticed the increasing use of fabricated steel construction, which was, perhaps, most strikingly exemplified in the new engine for three oil-electric locomotives, which, in conjunction with the B.T.H. Company, are being supplied for heavy shunting service at the Ford Motor Company's Dagenham works. The engines are six-cylinder units, each with a designed output of 150 B.H.P. at a normal speed of 550 r.p.m. They are of the trunk-piston type, and operate on the four-stroke principle with airless-injection. By means of a patented pneumatic contactor system, they can be run under governor control at 550, 350, 250 and 150 r.p.m., and embody many ingenious points in design. Other units included high-speed propelling engines for trawlers and coal barges, and some interesting engines for the power station of a block of residential flats, which were outstanding by reason of their very quiet running. In addition to the new engines we have referred to, which enable a greatly increased power to be obtained with much smaller engine weights, and proportionally lower costs, we were glad to observe, going through the shops, a wide range of turbines, pumps, and condensers, and some new designs which bore evidence of the spirit of initiative which is so charactistic of the firm's work.

## Proposed Nanking-Pukow Train Ferry.

WE are informed that the Chinese Government Purchasing Commission has placed a contract with Dorman, Long and Co., Ltd., for the construction of the two approach bridges for the Nanking–Pukow train ferry. Each approach will consist of four spans of 154ft. with 20ft. between trusses, widening out to 44ft. on the river span to accommodate three tracks leading to the ferry boat. The steel work will be manufactured at Dorman, Long and Co.'s works at Middlesbrough, whilst Thos. Broadbent and Sons, Ltd., will be responsible for the operating machinery. The Yangtse River at the ferry crossing has an extreme variation in water level of 28ft., with a daily variation of 1ft. to 3ft. The four spans which will connect the ferry boat to the shore on either bank will be carried on long screws. These screws are to be electrically operated, and will be interconnected in such a way that whatever the water level the necessary gradient will be produced over the spans from the shore to the ferry boat. The machinery for operating the screws will be situated on the top of the steel towers over the bridge piers. The ferry boat will be connected to the end of the river by an adjustable "apron" which will take up any minor variations in level of the deck during loading.

## Reorganisation of the Iron and Steel Industry.

IN connection with the movement to reorganise the iron and steel-producing industry, Sir Charles W. Wright, chairman of Baldwins, Ltd., has accepted the invitation of the Import Duties Advisory Committee to serve on the National Committee of Iron and Steel Producers. The four Regional Committees have elected their chairmen as follows:—North-East Coast, Mr. E. J. George, Consett Iron Company, Ltd., Consett, Co. Durham; Scotland, Mr. John Craig, Colville, Ltd., Glasgow; Midlands, Captain R. S. Hilton, United Steel Companies, Ltd., Sheffield; South Wales, Sir John Field Beale, British (Guest, Keen, Baldwins) Iron and Steel Company, Ltd. At a meeting last Friday under the chairmanship of Mr. C. Mitchell (chairman of the National Committee), the following were elected as Chairmen of the Special Industries Committees:—Wrought iron industry, Mr. C. E. Lloyd, N. Hingley and Sons, Ltd., Dudley; special steel industry, Mr. C. W. Kayser, Kayser, Ellison and Co., Ltd., Sheffield; armament and heavy forging industries, Mr. A. J. Grant, Thomas Firth and John Brown, Ltd., Sheffield; steel castings industry, Mr. H. G. Stobart, chairman, General Steel Castings Association. With further reference to the steel castings industry, we learn that a circular has been issued on behalf of the General Steel Castings Association to the owners of all carbon steel casting works in England, Scotland, and Wales, asking whether they would be prepared to sell their works for dismantling in order to get rid of redundant capacity. From the nature of the inquiry, it may be inferred that the intention is to follow the example set by National Shipbuilders Security, Ltd.

## Sugar Machinery.

IN reviewing the work of the past year at a meeting of shareholders held on Tuesday, 21st inst., Mr. Charles Day, chairman of Mirrlees, Bickerton and Day, Ltd., said the political unrest in so many countries, the insufficient distribution of gold, and severe taxation, were the main causes of the world-wide stagnation of trade; but notwithstanding the severe trade depression in this country, the conditions here were far better than in most other countries, and the reputation of Great Britain was even higher than hitherto. He said the sugar machinery section of The Mirrlees Watson Company's business had been fairly well employed, two very large cane-crushing plants having been supplied to a factory in Natal, while orders for six complete sugar factories had been received from India, where the Government had taken active steps to encourage the growth of sugar cane instead of cereals and other crops. To help in this direction, the Indian Government had increased the import duty to more than double on crystal sugar, of which about 1,000,000 tons were imported annually from Java, Formosa, &c. This action had greatly encouraged the cultivation in India of sugar cane and production of crystal sugar and had resulted in the orders just mentioned. Altogether seventeen factories had been ordered.

## Richardsons, Westgarth and Co., Ltd.

IN the report of the directors of Richardsons, Westgarth and Co., Ltd., for the year ending 1931, it was stated that of the three works owned by the company, one alone, that at Hartlepool, had been employed, those at Middlesbrough and Sunderland having been practically closed since the early part of 1930. The last contract for marine engines was received in July, 1930, when the order was secured for the quadruple-expansion engines of two large whaling factory ships. The delivery of these vessels in June and August of 1931 marked the completion of all marine work on order, and the company had since been dependent upon land contracts and repair work, which was, however, insufficient to keep even one works employed to normal capacity. In spite of the unchanged outlook in the shipbuilding industry, preparations had been made in anticipation of a trade revival. Owing to the continued depression of the marine engineering industry, the further development of the company's land work department had been under consideration, and arrangements had been practically concluded with Messrs. Brown, Boveri, of Switzerland, whereby it was hoped that there would be a considerable increase in the company's production of turbo-alternators and auxiliary plant for use on land.

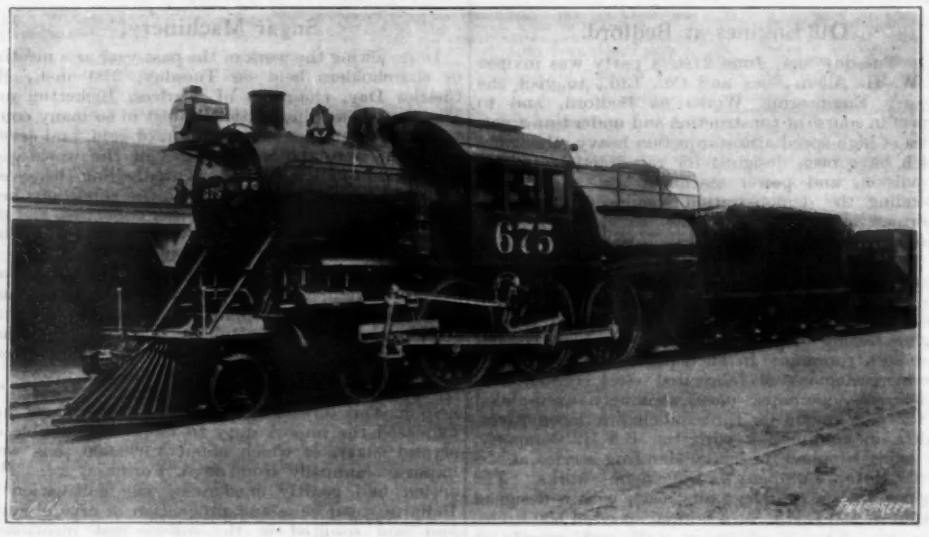
## Economies in Road Transport.

REPLYING to a discussion in the House of Commons on Tuesday on the Vote for the salaries and expenses of the Ministry of Transport, Mr. Pybus said that the road schemes proposed by the late Government represented an estimated expenditure of £60,000,000. These schemes had been designed to reduce unemployment, but they only gave work to one-third of 1 per cent. of the industrial population. The present Government did not consider that a road or a bridge was a suitable basis upon which to build an unemployment policy. Accusations had been preferred against the Ministry that its selection of works for retention or stoppage had been haphazard; actually, it had consulted every County Council and local authority in order to produce a tentative list that would be within the financial limits imposed by the Government. It had then discussed the proportions in which the money should be allotted to buying land, compensation of owners, and demolition of buildings. Under the late Government's scheme, the suggested improvement at Elephant and Castle, for example, was to cost £2,000,000, and of that no less than 72·3 per cent. was to be spent on property and only 27·7 per cent. on employment. Such a policy was unacceptable to the present Government, with the result that commitments had been reduced by between £35,000,000 and £40,000,000. Maintenance of highways was a costly item, chiefly owing to the damage caused to road beds by heavy vehicular traffic. Researches had been made into road surfacing, and a new technique was growing up all over the world. It was an extremely technical subject, and in his opinion merited a new technical department.

# Three-Cylinder Express Engines: Philadelphia and Reading Railroad.

By F. W. BREWER, A. Inst. Loco. E.

IN the years 1909–12 four very interesting three-cylinder non-compound express engines of considerable size and power were put into service on the Philadelphia and Reading Railroad of America. Three of the engines were "Atlantics," or 4–4–2's, and one was a 4–6–0, each locomotive being the first representative of its particular wheel notation to be fitted with a third cylinder, although not the first, independently of the wheel arrangement, to have three cylinders, in the United States. For several reasons, as will be seen, these Reading examples constituted a noteworthy link in the history of the type. At that period, the employment of triple cylinders in American locomotives was still quite exceptional, and in order to understand the then position of the matter, it will be as well to point out what had been previously done in the same connection.




THREE-CYLINDER 4-6-0 EXPRESS ENGINE

Briefly, the introduction of the three-cylinder simple type in America was contemporaneous with its appearance in Great Britain, but, as in the case of the latter country, the type made no headway at the time. The pioneer example in the United States was a 4–4–0 engine built, or perhaps more accurately, rebuilt, by the Philadelphia, Wilmington, and Baltimore Railroad—now absorbed in the Pennsylvania lines—either in December, 1847, or in January, 1848. It was, however, preceded in England by Stephenson and Howe's patented three-cylinder passenger engine, which, constructed in 1846, was ready for trial early in 1847. Here the higher cost of such a locomotive, as compared with one having two cylinders only, retarded the further development of the matter for more than fifty years, whilst in America the strong prejudice which eventually manifested itself against the employment of crank axles had a like effect. Many "inside-connected" two-cylinder engines were, nevertheless, built there until about 1853, when the standard so-called "American" type, with a pair of horizontal outside cylinders, as evolved by Rogers, began to be adopted, and finally decided the question, the inside cylinder engine being thereafter gradually discarded.

In the United States the object of adding a third cylinder appears to have been the same as that of to-day, namely, to obtain a better turning moment of the cranks. It differed from the end sought in the design of the Stephenson and Howe engine, in which the aim was simply to eliminate the swaying couple. For this purpose, the two outside cranks were disposed on the same corresponding centres, and moved together as one, and the single-throw middle crank was set at an angle of 90 deg. to the two external cranks. This engine, which was entirely reconstructed by the Stephensons in 1852, remained a three-cylinder one until 1860, when it was converted to the ordinary two-cylinder type.

Without going minutely into the history of the subject, it may be mentioned that the next triple-cylinder example in Great Britain was Mr. James Holden's purely experimental 0–10–0 tank engine, of 1902, on the erstwhile Great Eastern Railway, but the latter-day adoption of three high-pressure cylinders in reality dates from 1909, the credit for which was due to Mr. Wilson Worsdell, of the former North-Eastern Railway, and to his successor, Sir Vincent Raven. The practice then instituted afterwards extended to several other lines, including one Scottish railway. At the present time collectively, a very large number of three-cylinder simples are running on three of the grouped lines, viz., the L.M.S.R., the L.N.E.R., and the Southern, the G.W.R. so far not having built any such engines.

On the other hand, the idea of adding an extra cylinder was revived in America as long ago as 1880, in four 0–4–0 shunting engines, which had been built by the Pennsylvania Coal Company for service in connection with its mines. These engines were designed by Mr. J. B. Smith, the coal company's superintendent, who, some twelve years later, also designed a three-cylinder 4–4–0 for the Erie and Wyoming Valley—now Erie—Railroad. This engine was constructed by the Dunmore Iron and Steel Company in 1892, and during the same period the same railway applied the triple-cylinder plan to four 0–8–0's, and in 1894 to three 2–6–0's. These three last-mentioned engines were constructed by the Baldwin Locomotive Works, and had 17in. by 24in. cylinders, 4ft. 9in. coupled wheels, 150 lb. pressure, and a weight, minus the tender, of 56¼ British tons.

Chronologically, the four Philadelphia and Reading engines came next—in 1909–12—and they were therefore coeval with the reintroduction of the three-cylinder high-pressure engine, as an accepted type, in Great Britain. In size, weight, and power, the Reading locomotives were far ahead of the Erie and Wyoming Valley examples. Their average weight, for instance, without the tender was 100 British tons. They were, however, especially remarkable for having two different kinds of valve gear; also, as regards three of the engines, for having what in those days were very high working pressures for non-compound locomotives. Some misconception seems to have arisen in regard to these fine locomotives, the history of which is but indifferently known here, but which, by the kindness of Mr. I. A. Seiders, the present superintendent of motive power and rolling equipment of the Reading lines, the writer is enabled to bring up to date. It may be stated at once that all four engines are now running with two cylinders only, and the reason for this conversion will be duly given further on.

As already indicated, three were 4–4–2's while one was a 4–6–0. All were turned out at the Reading shops of the railway company, and were designed by Mr. H. D. Taylor, the then superintendent of motive power. The "Atlantics," which had 6ft. 8in. coupled wheels, were numbered "303," "300," and "344," and were completed in 1909, 1911, and 1912 respectively. The 4–6–0 was built in 1911. It was numbered "675," and had 6ft. 2in. driving wheels. Each engine was fitted with a large boiler of the Wootten type, 5ft. 5in. in diameter outside in "No. 303," and 5ft. 6in. in the others, having a long and wide fire-box, and the driver's cab placed in a midway position over the boiler. The length of the boiler barrel between tube plates was, in "No. 303," 15ft. 3in.; in "No. 344," 16ft.; and in "No. 300" and "No. 675," 15ft. 6in. The grate area was 90 square feet, except in the case of "No. 344," in which it was 94·5 square feet.

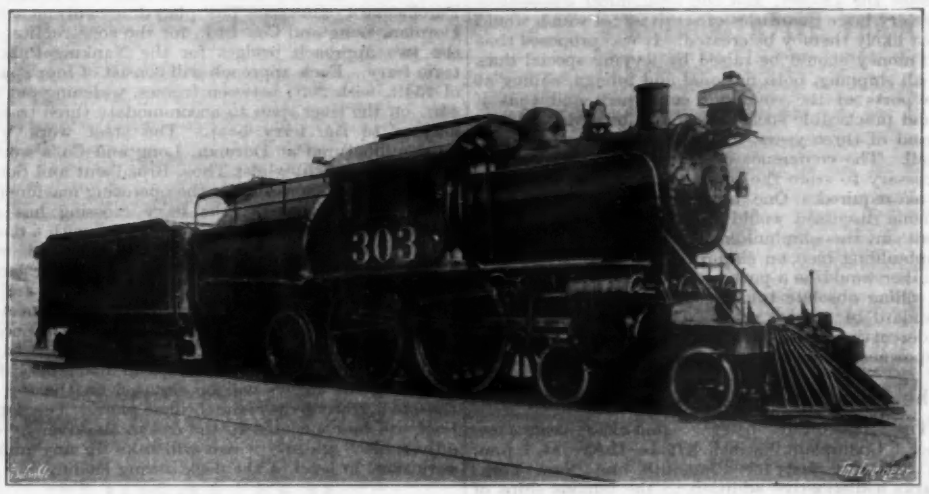
"Atlantic No. 303," the initial engine, had three 18½in. by 24in. cylinders, a steam pressure of 225 lb. per square inch, and a total heating surface of 2850 square feet. The weight of this engine, including 52 tons 9 cwt. on the four-coupled wheels, was 100 tons 19 cwt. The cylinders of the two other 4–4–2's, "No. 300" and "No. 344," were 19in. by 24in., and the working pressures were respectively 240 lb. and 230 lb. The total heating surface of "No. 300" was 3345 square feet, and that of "No. 344" 3018·5 square feet. In running order, "No. 300" weighed 99 tons 1 cwt., of which total 56 tons 13 cwt. were available for adhesion, but no official record is extant of the weight of "No. 344" at that time. As a matter of fact, the latter was not then a brand new engine, but was one rebuilt with three cylinders and new motion, identical with those parts in the other engines. It was also equipped with a Schmidt superheater when being reconstructed, and was the first Reading engine to have one, but the other engines were fitted with waste-heat superheaters designed by Mr. Taylor, and placed at the back of the smoke-box, the boiler barrel being divided by an intermediate tube plate, the tubes being therefore expanded in three flue sheets. The heating surface of the Schmidt superheater was 791·6 square feet, and that of the Taylor apparatus 684 square feet.

In the case of the 4–6–0, the three cylinders were again 19in. by 24in., and the working pressure was 240 lb. per square inch. The total heating surface amounted to 2983 square feet. The weight of this engine was 101 tons 4 cwt.; weight on six-coupled wheels, 77 tons 1 cwt.

It may be of interest to add that the diameter of the blast nozzle of "No. 303" was 6in., and that of the nozzles of the other engines, 6¼in.

All four engines had inside admission piston valves. The Joy motion was employed for operating the valve of the single inside cylinder, and the Walschaerts gear for actuating the valves of the two outside cylinders. The three cylinders were arranged in line transversely, and were horizontal, with a divided drive. The middle cylinder was connected up to the leading pair of coupled wheels by a balanced crank axle, and the external cylinders to crank pins on the second pair, the three cranks being arranged at an angle of 120 deg. to each other.

In consequence of the operation of a Federal law governing the factor of safety of steam boilers, the working pressures were subsequently lowered to 215 lb. per square inch. Schmidt superheaters were fitted, in December, 1915, to "No. 303" and "No. 675," in place of Mr. Taylor's device, while these engines were still of the triple-cylinder order, and to "No. 300" in April, 1917, after the latter had been rebuilt with only two cylinders.




THREE-CYLINDER 4-4-2 EXPRESS ENGINE

In point of speed and smooth running, the performance of the Reading three-cylinder locomotives was entirely satisfactory. The 4–4–2's were used on the Atlantic City expresses of the Philadelphia and Reading Railroad, on which service they frequently reached, and maintained for several consecutive miles, authenticated speeds ranging from 90 to 95 m.p.h.

After being at work for about five years the four engines were converted to the ordinary two-cylinder type, "No. 303" being so altered in September, 1916; "No. 300" in April, 1917; "No. 344" in June, 1917; and "No. 675" in July, 1916. As

converted, "No. 303" and "No. 300" each weighed 97 tons 2 cwt.; "No. 344" weighed 100 tons 9 cwt.; and "No. 675" turned the scale at 98 tons 13 cwt. All had new cylinders, 22in. by 26in., and all had—and still have—a boiler pressure of 215 lb., the four engines being still in service. The total wheel base of "No. 303," "No. 300," and "No. 675" is 28ft., and that of "No. 344" 29ft. 3in.

The change made from the triple-cylinder to the two-cylinder variety was brought about by crank-axle trouble. The crank axles, it seems, were constructed of three pieces. The centre pin and two crank cheeks were formed out of a single ingot, and the two outside axles were pressed into the cheeks. This turned out to be a very costly and unsatisfactory method of construction. The axles failed from time to time, and owing to the expense and delay involved in replacing them, it was deemed preferable to rebuild the engines with two cylinders only, and with straight leading coupled axles. If any other three-cylinder engines were to be designed by the Reading Company at any future period, the crank axles would, it is officially stated, be of five-piece construction. But, apart from the disability in question, the engines ran well, and acquired an excellent reputation for their high speed qualities in their three-cylinder form.

During the same—1909–1912—period, in which they were originally put into traffic, the company also built some two-cylinder engines, which, except for the differences incidental to the smaller number of cylinders, and the absence of the Joy gear, &c., were similar to "No. 300" and "No. 675," and worked at the high pressure of 240 lb. per square inch. The two-cylinder examples were "No. 301" and "No. 302," which were 4–4–2's, and "No. 676," which was a 4–6–0.

When new, the three-cylinder engines had double-bogie tenders holding 7000 gallons of water and about 9½ British tons of coal.

At the time referred to, these Reading engines constituted a notable departure from conventional American locomotive practice, and their history is therefore of no little interest to-day, when the employment of a third cylinder is by no means unusual.

The writer's thanks are due to Mr. I. A. Seiders for the information supplied, and for the photographs of "No. 303," a 4–4–2, and "No. 675," the 4–6–0, as originally built with triple cylinders, which are reproduced with this article.

It may be added that the P.W. and B. Railroad apparently had two, and possibly three, engines of three-cylinder kind in the 1847–48 period.

## The Estimation of Gas Turbine Nozzle Throat Area.

By GEORGE G. McDONALD, B.Sc., A.M.I.N.A.
(James Watt Engineering Laboratories, University of Glasgow).

IT is well known that the efficiency of the "entrance" or convergent portion of the convergent-divergent steam nozzle is very nearly unity. The practice of designing the throat area of such a nozzle on the assumptions that adiabatic expansion takes place between inlet and throat and that equality between the "stream velocity" and the "local" velocity of sound occurs at the latter section is thus justifiable and leads to reasonably accurate results.

It would appear, however, from the relatively low values of the "velocity coefficient" obtained by Dr. E. C. Wadlow* in his experiments on the nozzle flow of high-temperature combustion gases, that the efficiency of the convergent-divergent gas nozzle is considerably lower than that of similar steam nozzles, and it is reasonable to suppose that the efficiency of the entrance portion of the former nozzle will be appreciably less than unity, and that in its design the assumptions of adiabatic expansion in the entrance, and acoustic conditions at the throat, are no longer valid.

In the present note, expressions for the conditions existing at and in the neighbourhood of the throat of a gas nozzle for both ideal and polytropic expansions are stated, and a comparison is made of nozzle throat areas, for the same mass flow, as calculated first of all assuming that the expansion in the entrance is adiabatic, and then, taking the efficiency of the nozzle entrance into account. The difference is shown to be far from negligible, the area of the throat of the inefficient nozzle being larger than that of the ideal nozzle, by an amount equal to about two thirds of the percentage difference between unity and the entrance efficiency of the former nozzle. It is suggested that in view of this difference the effect of nozzle entrance efficiency is important enough to be taken into account in the design of gas turbine nozzles. The entrance efficiency of a convergent-divergent gas nozzle could as a fairly good approximation be assumed to be the same as the efficiency of a simple convergent nozzle having a form similar to the convergent portion of the convergent-divergent nozzle, and expanding from the same initial conditions to a pressure slightly above the critical pressure.

### FRICTIONLESS EXPANSION OF A PERFECT GAS IN AN IDEAL NOZZLE.

Consider the adiabatic expansive flow of a perfect gas ($\gamma = C_p/C_v$ = constant) from rest under initial conditions of absolute pressure $p_i$, absolute temperature $T_i$, density $\rho_i$, and velocity ($U_i = 0$), respectively—to final conditions $p_f$, $T_f$, $\rho_f$, and $U_f$,—the expansion proceeding according to the law

$$p = \rho^{\gamma} \times \text{constant} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The following well-known relationships apply at the "throat" of the ideal nozzle :—

$$p_{ta} = p_i \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} \quad . \quad . \quad . \quad . \quad (2)$$

$$T_{ta} = T_i \left(\frac{2}{\gamma+1}\right) \quad . \quad . \quad . \quad . \quad (3)$$

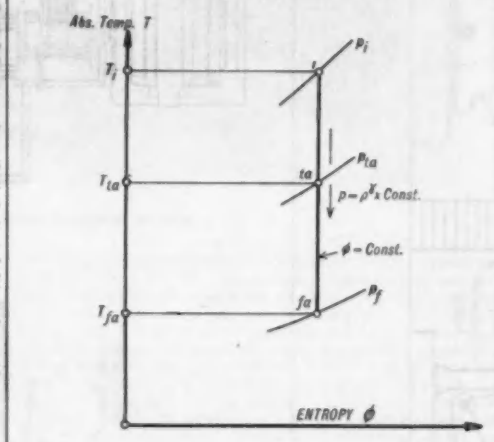
$$\rho_{ta} = \rho_i \left(\frac{2}{\gamma+1}\right)^{\frac{1}{\gamma-1}} \quad . \quad . \quad . \quad . \quad (4)$$

$$U_{ta} = A_{ta} = \left(\frac{2\,\gamma\,R\,T_i}{\gamma+1}\right)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad (5)$$

where $p_{ta}$, $T_{ta}$, $\rho_{ta}$, $U_{ta}$, and $A_{ta}$ represent the absolute pressure, absolute temperature, density, stream velocity, and acoustic velocity respectively at the throat, R being the gas constant. The throat area $A_{ta}$, necessary for dealing with M lb. of gas per second is

$$A_{ta} = M \Big/ \rho_{ta} U_{ta} = M \Big/ \rho_i \left(\frac{2}{\gamma+1}\right)^{\frac{1}{\gamma-1}} \left(\frac{2\,\gamma\,R\,T_i}{\gamma+1}\right)^{\frac{1}{2}} . \quad (6)$$

Fig. 1 shows the path $i\,t_a\,f_a$ traced out on the temperature-entropy field by the state point of the



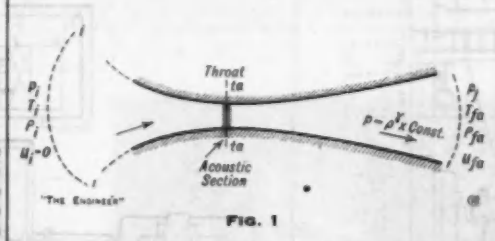




FIG. 1

gas for the type of expansion considered. The points $i\,t_a\,f_a$ represent respectively conditions at the inlet, throat, and outlet sections of the nozzle.

### POLYTROPIC EXPANSION OF AN ACTUAL GAS IN AN IMPERFECT NOZZLE ENTRANCE.

Assume in this case, for simplicity, that the ratio $\gamma$ of the specific heats of the actual gas is sensibly constant throughout the expansion. Suppose the expansion to begin under the same conditions, $p_i$, $T_i$, $\rho_i$ ($U_i = 0$) as in the ideal case, and to end under conditions $p_f$, $T_f$, $\rho_f$, and $U_f$. Also assume the flow in the *entrance* to be represented by

$$p = \rho^n \times \text{constant} \quad . \quad . \quad . \quad . \quad . \quad (7)$$

in which $n$ the index of the polytropic expansion is assumed to be constant, and to have some value between 1 and $\gamma$, depending on the value of $\eta_i$, the efficiency of the entrance of the nozzle.

It can be shown that $n$ is given in terms of $\eta_i$ and $\gamma$ by

$$n = \frac{\gamma + 1 + \eta_i(\gamma - 1)}{\gamma + 1 - \eta_i(\gamma - 1)} \quad . \quad . \quad . \quad . \quad (8)$$

The following expressions can be derived representing the conditions at the throat of the imperfect nozzle :—

$$p_t = p_i \left(\frac{2}{n+1}\right)^{\frac{n}{n-1}} \quad . \quad . \quad . \quad . \quad (9)$$

$$T_t = T_i \left(\frac{2}{n+1}\right) \quad . \quad . \quad . \quad . \quad (10)$$

$$\rho_t = \rho_i \left(\frac{2}{n+1}\right)^{\frac{1}{n-1}} \quad . \quad . \quad . \quad . \quad (11)$$

$$U_t = \left(\frac{2\,\gamma\,R\,(n-1)\,T_i}{(\gamma-1)\,(n+1)}\right)^{\frac{1}{2}} \quad . \quad . \quad (12)$$

$$A_t = \left(\frac{2\,\gamma\,R\,T_i}{n+1}\right)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad (13)$$

where $p_t$, $T_t$, $\rho_t$, $U_t$, $A_t$ have the same meanings as in the ideal case.

It may be stated as a matter of interest that in the type of polytropic expansion considered here there exist two "critical sections" in the nozzle: first, the "throat" or section of critical *form*, at which the cross-sectional area of the nozzle attains its minimum value, and the rate of mass flow, its maximum value; and secondly, a section of critical *velocity* at which the stream velocity equals the "local acoustic velocity" or the velocity of sound in the gas under the temperature conditions at the section. This critical velocity section is situated at a short distance downstream from the throat, in the diverging portion of the nozzle. In adiabatic expansion, however, the critical velocity section coincides with the throat.

The pressure $p_c$ at this critical velocity section can be shown to be

$$p_c = p_i \left(\frac{2}{\gamma+1}\right)^{\frac{n}{n-1}} \quad . \quad . \quad . \quad . \quad (14)$$

and the absolute temperature $T_c$ at the same section

$$T_c = T_i \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} \quad . \quad . \quad . \quad . \quad (15)$$

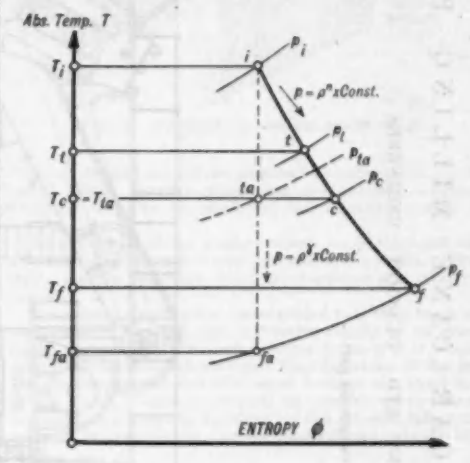
and the stream velocity $U_c$ and acoustic velocity $A_c$ are

$$U_c = A_c = \left(\frac{2\,\gamma\,R\,T_i}{\gamma+1}\right)^{\frac{1}{2}} \quad . \quad . \quad . \quad . \quad (16)$$

The area $A_t$ of the throat of the imperfect nozzle is then

$$A_t = M \Big/ \rho_t\, U_t = M \Big/ \rho_i \left(\frac{2}{n+1}\right)^{\frac{1}{n-1}} \left(\frac{2\,\gamma\,R\,(n-1)\,T_i}{(\gamma-1)\,(n+1)}\right)^{\frac{1}{2}} (17)$$

Fig. 2 illustrates the polytropic type of expansion, which commences at $i$, passes through the throat



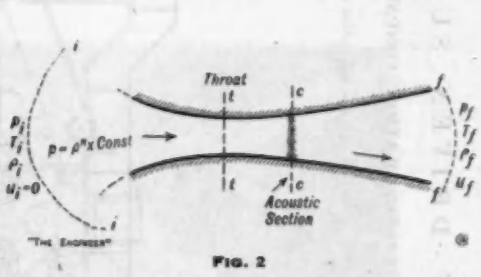




FIG. 2

point $t$ and critical velocity point $c$ respectively, and finishes at $f$.

### COMPARISON BETWEEN AREAS OF IDEAL AND IMPERFECT NOZZLE THROATS.

Taking as an example the case of a gas turbine nozzle for which $\eta_i = 0{\cdot}95$, dealing with a gas for which $\gamma = 1{\cdot}4$ and constant, $n$ is found from (8) to be $1{\cdot}375$, and the ratio $A_t/A_{ta}$ from (17) and (6) is found to be $1{\cdot}035$, showing that when ideal expansion is assumed the throat area is underestimated by about 3½ per cent. for the chosen values of entrance efficiency and specific heat ratio.

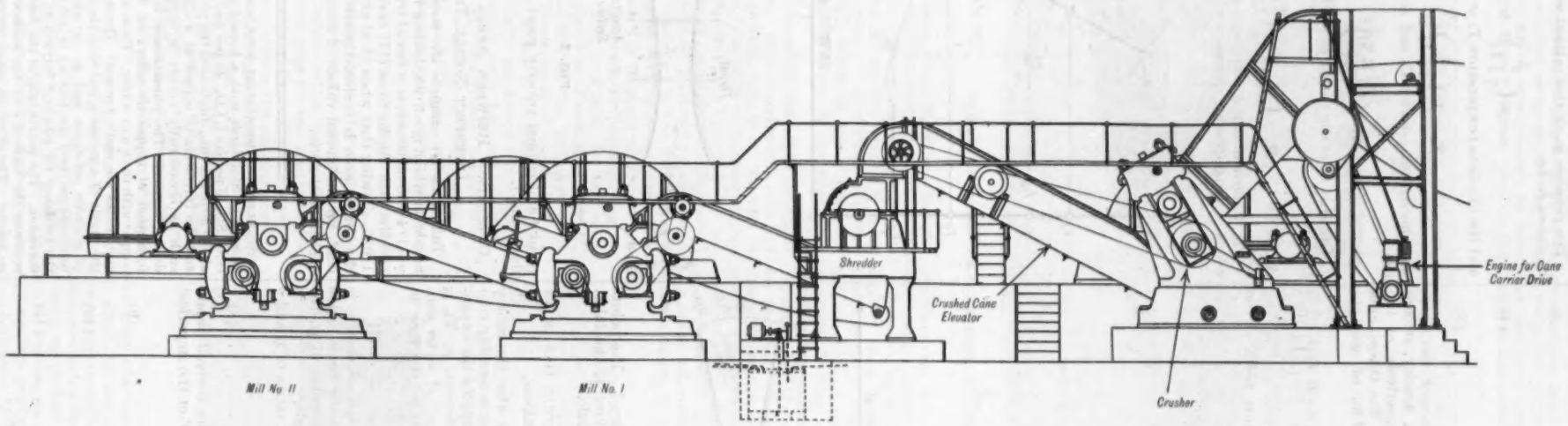
ACCELERATED weathering tests made by the American Bureau of Standards with a humid gas mixture of 1 per cent. $SO_2$, 5 per cent. $CO_2$, 94 per cent. air at temperatures above 50 deg. Cent., duplicated the pitting of tinned copper and the furrowing of copper at a copper-solder junction, such as occasionally occurs in copper roofing material during service. The phenomenon is associated with the formation of copper-tin alloys at the junction of the copper with the tin or solder. These alloy layers are brittle and cracks are easily formed. The exposed copper forms the anode of a galvanic cell with the alloy in the presence of suitable solutions and is corroded. The higher the temperature used for tinning or soldering, the greater is the tendency for pits and furrows to form by subsequent corrosion. The prevention of the formation of such alloys removes the tendency of the soldered copper to pit and to furrow. The effect of seam corrosion is to reduce the strength of soldered joints and to impair markedly the fatigue properties of the copper as measured in terms of the number of bends required to produce failure. Spilt flux, if left in place, causes pitting of copper. This pitting occurs under very adherent deposits of copper salts, which are not removable by water. The presence of thin oxide films on copper brings about deeper pitting. In such cases, when sodium-chloride solutions are used, porous cuprous-oxide deposits are found under the layer of copper salts which causes the pitting.

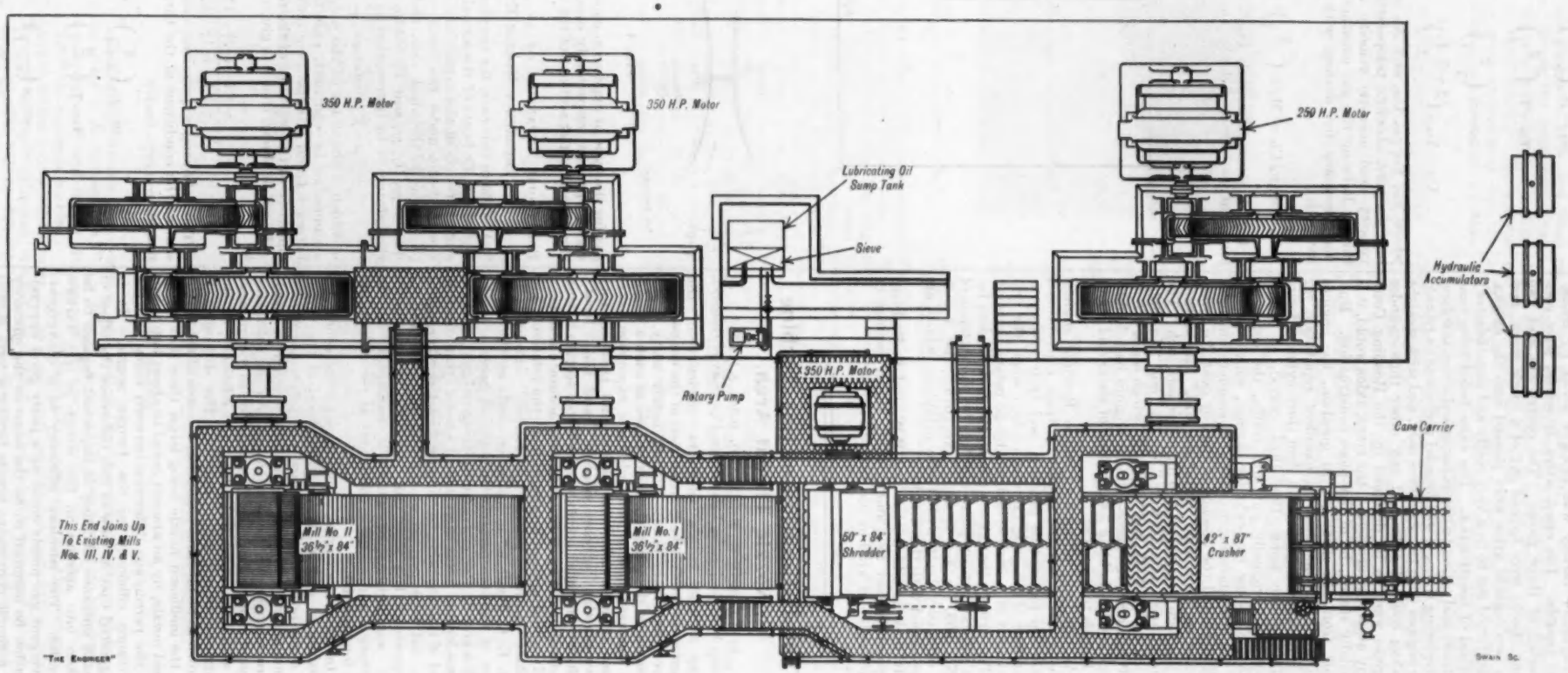
* Proc. Inst. Mech. E., 1928, page 405 *et seq.*

# ELECTRICALLY-DRIVEN SUGAR CANE MILLING PLANT

THE MIRRLEES WATSON COMPANY LTD., GLASGOW, ENGINEERS

(*For description see opposite page.*)



# Electrically-Driven Sugar Cane Mills for Natal.

In the following article we describe and illustrate a large electrically driven sugar cane milling plant, which has recently been completed by The Mirrlees Watson Company, Ltd., of Scotland-street, Glasgow, and is now erected ready for work at the Mount Edgecombe factory of the Natal Estates, Ltd., of Durban, South Africa. The plant incorporates several new and interesting features, and we were permitted, by the courtesy of the builders, to inspect it on various occasions during its construction and assembly in Glasgow before shipment.

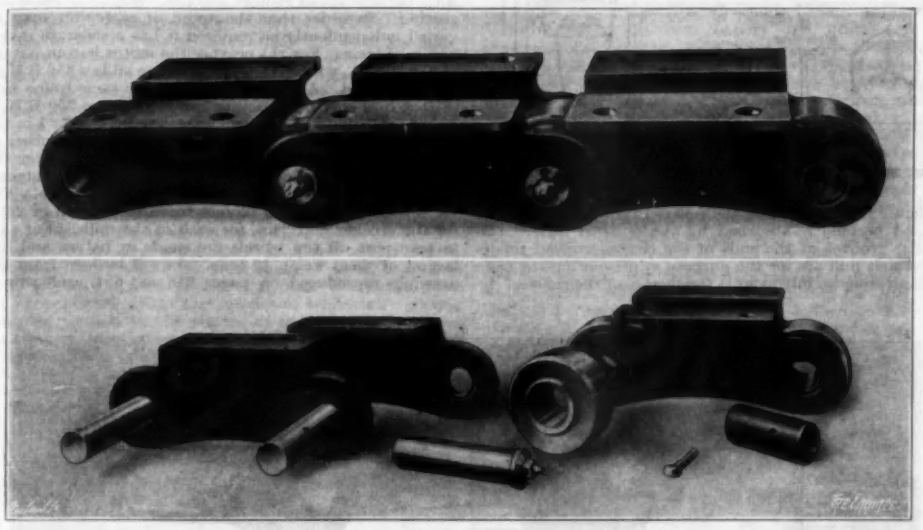


FIG. 1—CANE CARRIER ROLLER CHAIN

As the drawing reproduced on page 686 indicates, the new plant comprises a steam engine driven cane carrier with superimposed cane knives. The carrier delivers the finely cut cane to a two-roller 42in. diameter, 87in. long crusher, which is followed in turn by a 50in. by 84in. Searby cane shredder and two 36½in. by 84in. three-roller cane mills. A view of the plant erected in the maker's works is reproduced on page 694. The whole of the crushing and milling plant is electrically driven through gearing, and is complete with intermediate bagasse carriers, service platforms, &c. The new plant joins up to the existing Nos. III., IV., and No. V. mills.

The history of the Mount Edgecombe plant is an interesting one. In 1908 the owners ordered from The Mirrlees Watson Company, Ltd., the first fourteen-roller sugar cane milling plant to be installed in South Africa, the first in the world having been supplied by the same firm for Java in the preceding year. The rollers of the first Mount Edgecombe mills are 32in. in diameter, with a length of 66in., and they are driven by horizontal steam engines, which, it may be stated, have been in regular service since they were installed. In 1921 a Searby cane shredder was added, and in 1927 a fifth Mirrlees mill, with rollers 36½in. in diameter and 84in. in length, was inserted in the train. Owing to the steady increase in the cane crop dealt with at the Mount Edgecombe factory, the plant had in 1931 to grind from 70 to 75 tons per hour of Uba cane, containing 15 to 16 per cent. of fibre, and when such a duty was reached, it was decided to order the new milling plant we are describing. The alterations to the plant and the installation of the new machinery have all had to be carried out between the grinding seasons, and the present new mills are now to be followed by the existing third and fourth 32in. by 66in. mills and the fifth 36½in. by 84in. mill. At a later date the two small mills will be also replaced by 36½in. by 84in. mills, and then the whole of the milling train will grind 130 tons per hour of Uba cane of 16 per cent. fibre content.

We shall now describe the new milling plant, starting from the cane carrier end.

### CANE CARRIER AND CANE KNIVES.

The cane carrier, which is shown in both plan and elevation on page 686, has a width of 84in. and is constructed entirely of steel. The carrier framework was fabricated in Durban by Messrs. Gilbert Hanner and Co. The carrier apron consists of corrugated steel slats, which are attached to three strands of bushed roller chain. Fig. 1 shows the detailed construction of this chain, which is novel in its design. The side bars are cut out by a patented automatic flame cutting machine from high tensile rolled steel angle sections, the wider and thicker side of the section forming the deeper side of the link, and the narrower and thinner side of the section the face to which the steel slats are attached. The rollers, which are hardened and ground have a pitch of 6in. and are 2¾in. in diameter and are mounted on case-hardened bushes, which fit over high-tensile steel pins. As shown in the illustration, the pins are drilled for lubrication and are furnished with nipples for grease gun service. Each chain has an ultimate strength of 72,000 lb.

The cane carrier is operated by a two-cylinder steam engine of the enclosed pattern, which drives it through a chain and a compound speed-reducing gearing designed to give a large range of operating speeds. As shown on page 694, the revolving cane knives, which are of the Mirrlees heavy-duty type, are mounted over the cane carrier just above ground level. The knives are protected by a steel plate casing furnished with a guard cover, an inspection door, and with swing doors adjacent to the inlet side of the cane knives. The enclosing of the knives obviates undue windage and prevents cane chips from being thrown out. The knives are driven by a 300 B.H.P. direct-coupled motor through a flexible coupling, and the spindle runs at 500 revolutions per minute. The renewable cutting blades are quite short, are directly attached to the cast steel hubs, and are made of shock-resisting steel with a cutting edge of hard wear-resisting alloy welded on to it.

### THE CANE CRUSHER.

The cane crusher, a view of which is reproduced in Fig. 2, has two iron and steel mixture rollers, each 42in. diameter with a length of 87in., which are mounted in heavy cast steel headstocks. A feature of the crusher is to be seen in the cast steel hydraulic pressure regulator caps of the latest Mirrlees design. Caps of the same type are fitted on all the mills. One of these caps is shown in part section in Fig. 3. The design permits of the leathers being changed in the minimum of time. By simply giving a 90 deg. turn to the top cover, which is of the breech block type, it may be lifted clear, then the top leather and the light brass distance ring may be quickly removed, giving access to the lower leather, which is pulled out by hooks. After the new leather has been fitted, the regulator cap is reassembled in the reverse manner and pressure applied. It will be noted that it is unnecessary to disturb any of the pipe joints. The lower leather, as shown in Fig. 3, bears against the polished steel ram of the regulator, and when this part becomes worn it can be removed and repolished or ground, a new bronze backing ring being fitted. The simple operations we have referred to are such, it is claimed, as can be carried out in any cane sugar factory with the appliances usually provided.

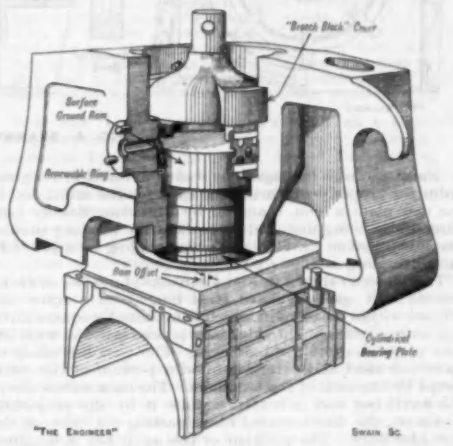



FIG. 3—HYDRAULIC REGULATOR CAP

As will be seen from the regulator cap drawing, Fig. 3, and the mill drawing, page 694, the centre line of the mill hydraulic regulators is set slightly forward of the centre line of the top roller, so that the line of pressure of the ram tends to counteract the couple which results from the unequal pressures between the top and front, and the top and the back rollers. Tipping of the bearing bush which would cause it to bind in the headstock is thereby prevented. The tendency of the top bearing bush to tip is also counteracted by the special design of the steel pressure plate, which is so formed as to give a positive and stable pressure against tipping, whilst it allows for the uneven lift of the top roller along its other axis by means of a cylindrical bearing surface.

The gun-metal bearings of the crusher bushes are provided with wedge adjustment between the rollers. As shown in Fig. 2, the rollers are of a modified "Krajewski" type, the ridges and grooves being arranged circumferentially instead of longitudinally. This particular design of roller was patented by Aitken in 1907—British patent No. 25,851—and it has recently come into prominence in South Africa.

The cast steel roller pinions for both the crusher and the mills have machine-cut teeth, and are designed so as to run smoothly at the varying centres necessitated by wear of the rollers and by the rise and fall of the top rollers. After prolonged service the pinions can be reversed on the roller shafts, thereby presenting new driving surfaces, enabling them to be employed for a further period of service.

All the shafts of the crusher rollers are of the same size and are interchangeable with the mill roller shafts. They have journal bearings 19in. in diameter and 28in. in length.

The bearing bushes are water cooled and they have, on account of their large size, a positive supply of oil introduced at both ends of each bearing by means of chain-driven mechanical lubricators. The flat sides of the top bearing bushes are also lubricated both at the front and at the back in order to prevent any undue wear of parts and to ensure complete freedom for the rise and fall of the roller in the headstock. As our illustrations indicate, the crusher is mounted on two heavy cast steel stools, to which the headstocks are secured by means of high-tensile steel bolts which pass right through the headstock and the cap. A screen of special design is fitted around the lower portion of the bottom roller to intercept the crushed cane, which would otherwise fall into the bed-plate along with the expressed juice. There are also portable guards which prevent juice from splashing outside the bed-plate. When removed, they allow access both to the juice tray and to the lower end of the crushed cane elevator. The crushed cane elevator is of the scraper type and conveys the cane from the crusher to the feed hopper of the cane shredder. It is driven by sprocket wheels and bushed roller chains from the bottom roller of the crusher, and a powerful

FIG. 2—CANE CRUSHER

friction clutch permitting of its disengagement, when necessary, is provided.

### The Cane Shredder.

After an experience of over ten years in the operation of the Searby shredder dealing with the high-fibre Uba cane of Natal the mill management was convinced of its great value for properly preparing the cane for the mills, and in the new plant a 50in. diameter by 84in. long Searby cane shredder is being installed to replace the existing smaller one. It is driven through a flexible coupling by a 350 H.P. motor running at 1000 r.p.m.

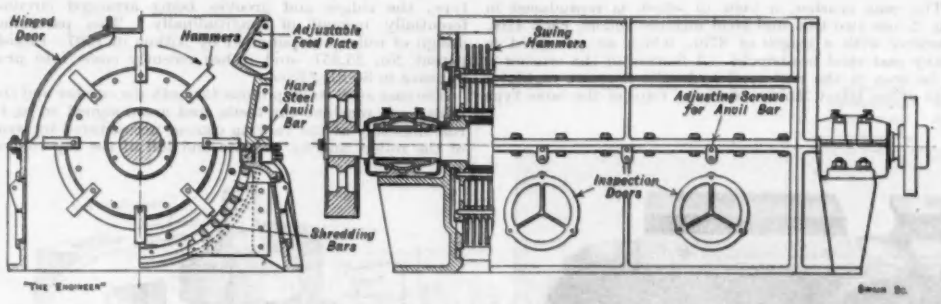



FIG. 4—SEARBY CANE SHREDDER

The shredder shown in Fig. 4 consists of a series of swing hammers of specially hard steel hinged on a rotor and housed within a casing in which is mounted a square anvil bar with a series of shredder bars spaced parallel with the axis of rotation of the hammers. The bars are made of hardened steel and extend around a portion of the circle swept by the ends of the hammers. The cane enters above the anvil bar and is beaten against it by the projecting hammers, the disintegrated fibres passing out between the shredder bars. The position of the anvil bar is designed so that it can be adjusted and is normally set about ¼in. clear of the hammer tips. No juice is extracted or liberated during the shredding process. The shredder simply reduces the cane to a loose fibrous mass, which readily feeds into the first mill, to which it is conveyed by a slat carrier. Fig. 5 shows the carriers to and from the shredder in course of erection.

### The Two Cane Mills.

The two mills which are now being installed are of the firm's heavy duty pattern with 36¼in. nominal diameter by 84in. long rollers, and, as shown on page 694, they have headstocks of cast steel mounted on cast iron bed-plates, deep sloping juice trays on either side of the mill being fitted. The hydraulic pressure regulator top caps, previously referred to, and the side caps are made of cast steel and are secured with high-tensile alloy steel bolts. As indicated, the top cap bolts pass through the cap, the headstock and the bed-plate, so that the main stresses are taken up, not by the headstock, but by the high-tensile steel bolts themselves.

The arrangement of the trashbar is clearly illustrated on page 694. It is of cast steel and is rigidly supported on a wide shelf cast on to the headstocks. As shown in Fig. 6, both horizontal and vertical adjustments by means of jack screws and locking blots are provided. The trash-plates, serrated to match the roller grooving, are made from Mirrlees "Wearever" steel, and are secured to the trashbars by through bolts of stainless steel. These special steel trashplates have been fully tested at the Mount Edgecombe factory, one plate having been, we understand, used for three seasons. During this period over 880,000 tons of cane were passed through the one 32in. by 66in. mill train with very little wear. Fig. 7 shows the coarse grooving adopted for the mill rollers. The grooving of the first mill is of 2in. pitch and that of the second 1in. pitch. Both the front and the back rollers of the second mill have, as shown in Fig. 7, "Messchaert" juice grooves, which are $^{7}/_{32}$in. in width, 2¼in. deep, and 2in. in pitch. The purpose of these grooves is to provide at the point of highest pressure a direct path for the discharge of the juice expressed. If these grooves were not provided the juice expressed at the point of highest pressure would either have to force its way back against the incoming feed, so causing the rollers to slip, or would pass on and become re-absorbed by the crushed cane. The smaller grooves at the ends of the coarse-grooved rollers of the first mill are for the purpose of preventing the cane from pressing unduly against the flanges of the rollers.

FIG. 5—CARRIERS FOR CRUSHED AND SHREDDED CANE

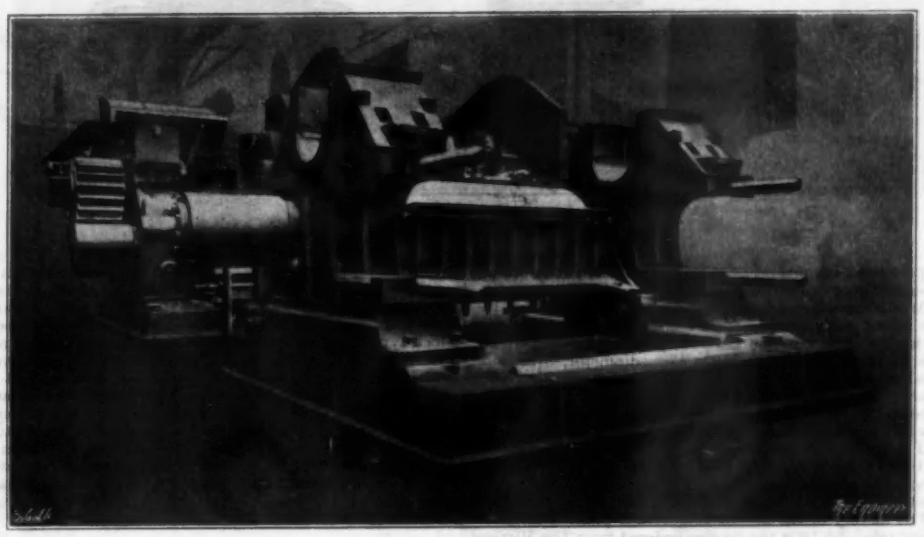


FIG. 6—MILL DURING COURSE OF ERECTION

The mill roller bearings are made throughout of hard gun-metal and are water cooled, each having a supply of lubricating oil at either end. A novel feature of the top roller bearings shown on page 694 is the provision of nitrarded steel rubbing plates in the gap of the headstocks in order to take the thrust on the top roller bearing bush which is caused by the reaction of the more heavily loaded back roller. Nitrarded steel, we may remark, is made from a special brand of steel manufactured by Thomas Firth and John Brown, Ltd., of Sheffield, which undergoes special treatment during which it is soaked in an atmosphere of ammonia for eighty hours at a temperature of 500 deg. Cent. The result is a glass-hard surface which is extremely resistant to abrasive wear. The nitrarding treatment is carried out by the Mirrlees-Watson Company, Ltd., under licence from Nitralloy, Ltd., the firm being the district licencees for this special process.

The hydraulic accumulators which are indicated in outline on page 686 do not call for a special description, as they are of the conventional differential pattern, all the pressure parts being made of wrought steel. The maximum working pressure is 4000 lb. per square inch, which gives a maximum loading of 650 tons on each top roller of the crusher and the two mills.

### Driving Arrangements.

The cane crusher and the two mills are operated by A.C. variable-speed motors through compound reduction gearing. In order that the speed of each unit may be varied independently as required it has a separate motor and gear train. For the crusher the motor has an output of 250 B.H.P., while for each of the two mills a 350 B.H.P. motor is fitted. All the motors have the same frame size, so that it is only necessary to carry one spare 350 B.H.P. motor. The reduction gearing has a ratio of 162 : 1 in the case of the crusher and 137 : 1 for each mill. It consists of cast steel double helical machine-cut gear wheels for the first and second motions, which mesh with pinions integral with the first motion and the intermediate shafts. The second motion gears all have a tooth face width of 24in. for the crusher and 28in. for each of the mills. For ease in transport all the wheels are made in halves and the largest of them weigh 12 tons. As will be seen from the drawings reproduced on pages 686 and 694, each pair of gears is totally enclosed. The case is oil-tight, dust-proof, and made of mild steel. In addition to the jointing angles, the gear cases are furnished with angle steel ribs on all flat surfaces so that resonance effects are counteracted and noise is eliminated as far as possible. Our illustrations show the very complete equipment of service platforms and stairways which give easy access to the machinery and simplify its superintendence. The gearing is supplied with lubricating oil from a motor driven rotary displacement pump complete with strainer and sump tank, oil being supplied under pressure to all bearings and also to each pair of gear wheels.

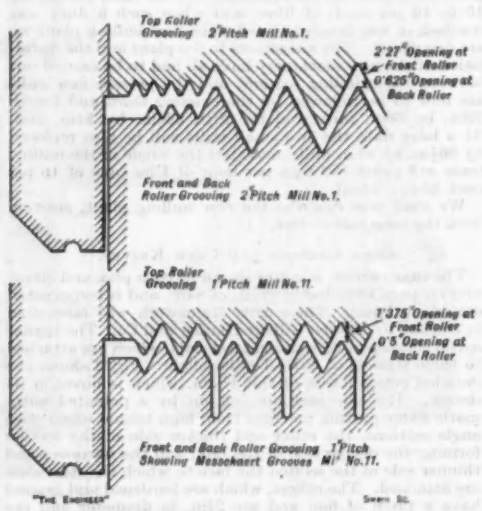

Top Roller Grooving 2" Pitch Mill No.1.
2·27" Opening at Front Roller
0·625" Opening at Back Roller
Front and Back Roller Grooving 2" Pitch Mill No.1.
Top Roller Grooving 1" Pitch Mill No.11.
1·375" Opening at Front Roller
0·5" Opening at Back Roller
Front and Back Roller Grooving 1" Pitch Showing Messchaert Grooves Mill No.11.
"The Engineer"

FIG. 7—GROOVING OF MILL ROLLERS

The milling plant we have described is one which is representative of the latest practice of the Mirrlees Watson Company, Ltd., and is without doubt an outstanding example of modern sugar mill equipment.

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It has been found necessary to dredge Bowness Bay on account of the unusual low level of the water in Lake Windermere.

# Macquorn Rankine.*

By Sir JAMES B. HENDERSON, D.Sc.

IT is more than fitting that a tribute should be paid in this University to the memory of William John Macquorn Rankine, who occupied the Chair of Engineering from 1855 until his death in 1872. On the occasion of the Rankine Centenary in 1922, the late Professor Barr, a most distinguished follower of Rankine in the professorial chair, gave an address to the Royal Philosophical Society of Glasgow, which is an excellent appreciation of the man and his work. In that address Professor Barr deplored the fact that no life of Rankine had been written by one of his contemporaries to give us a lasting impression of the man and his times, such as was written of Lord Kelvin by Silvanus Thompson. Practically the only published records of the life of Rankine consist of a two-column obituary notice in the *Glasgow Herald* written by Professor Tait, of Edinburgh, which was republished and enlarged as an introduction to Rankine's "Miscellaneous Scientific Papers," and an article by Maxwell published in *Nature* in 1878, six years after his death.†

While the material regarding the man, his character, his life, his ambitions and the factors and people who influenced his life and work is so small, his scientific work is so voluminous and so original that it provides ample material for an extension of the appreciations which have already appeared. In his Centenary Address, Professor Barr admitted that lack of time compelled him to deal almost exclusively with Rankine's work as an engineer, so on this occasion, while not ignoring his contribution to the science of engineering, I propose to deal at greater length with some matters to which Professor Barr devoted less attention, namely, the great problems with which physicists in his day were struggling, and the part which Rankine played in their solution.

But, first of all, it is necessary to give a brief summary of his life. Rankine was born in Edinburgh on July 5th, 1820. His father, David Rankine, had been an Army officer in his youth, but had retired and taken to civil engineering. His mother was Barbara Graham, a daughter of Archibald Graham, of Drumquhassle and Dalmarnock, a prominent citizen of Glasgow, and one of the founders of the Chamber of Commerce and of the Royal Infirmary. The Rankines were an old Ayrshire family descended from the Rankines of Carrick and the Cochranes of Dundonald, while the Grahams traced their lineage from Robert the Bruce through the Grahames of Douglaston.

Of Rankine's early life little is known. He records among his earliest recollections the religious instruction given to him by his parents, while his early tuition in arithmetic and elementary mechanics and physics was obtained from his father. His schooling was brief. He attended Ayr Academy in 1828–29, and the High School of Glasgow in 1830. In that year the family removed to Edinburgh, but on account of bad health the boy never returned to school, and for the next six years his remaining elementary education was carried out by private study at home, supervised and guided by his father, assisted by some tuition in geometry by a Mr. George Lees. Rankine records that in 1834—he was then fourteen years of age—"My uncle Archibald Graham gave me a copy of Newton's "Principia" (in the original Latin, of course), which I read carefully; this was the foundation of my knowledge of the higher mathematics and dynamics and physics."

For two sessions (1836–38) he attended in Edinburgh University the class of natural philosophy under Professor Forbes, and classes in chemistry, natural history and botany. Professor Forbes was one of the greatest workers of the time in the science of heat, and this no doubt influenced the later career of his pupil. In his first session, when only sixteen years old, Rankine gained the gold medal for an essay on "The Undulatory Theory of Light," and in the second year he was awarded an extra prize for an essay on "Methods of Physical Investigation." In these two years he also read metaphysics and, as he afterwards told Professor Tait, "wasted" much time in the study of "the theory of numbers." A different side of his many-sided nature is shown during these years in Edinburgh by his study of the theory and practice of music.

Family circumstances made it necessary for him to adopt a profession, so he joined his father, who was then superintendent of the Edinburgh and Leith Railway. After assisting his father for a time he became a pupil of Sir John Macneill, one of the foremost civil engineers of the day, by whom he was employed on various surveys and schemes for river improvements, waterworks and harbours, also for a time on the Dublin and Drogheda Railway. It was while working on this railway that he devised his method of setting out railway curves, which is still standard and is known to-day as "Rankine's method." Up to the year 1848 he seems to have been continuously employed as a civil engineer in various schemes, but in that year there occurred a sudden change which it is impossible to explain. The practical civil engineer suddenly becomes the theoretical physicist, and from 1848 until he became Professor in 1855 Rankine's energies seem to have been devoted almost entirely to those researches in molecular physics which gained him his Fellowship of the Royal Society in 1853.

The Chair of Engineering in Glasgow University was founded by Queen Victoria in 1840, Lewis Gordon, a prominent civil engineer of the period, being appointed as the first incumbent. In 1855 Rankine acted temporarily as a substitute for Gordon with such outstanding success that when the latter retired in the autumn of that year Rankine was appointed as his successor.

Ill-health, however, which had long dogged him, and which was possibly accelerated by the death of his father in 1870 and of his mother in 1871, to both of whom he had been most deeply attached, fated that he should not long occupy the professorial chair. He suffered more and more from acute headaches and latterly from failing eyesight, and in December, 1872, when only fifty-two years of age, he died of a general decline rather than of any specific disease.‡

Such is a brief summary of Rankine's short life, but of the work which he packed into that life volumes could be written. In the time at my disposal I can only hope to give a mere outline sketch.

As an illuminating commentary on his work as a whole, it is appropriate to remember that when he was appointed Professor in this University he was required to pass a test of ability, which he did by reading to the Senate a Thesis in Latin, the title of which I shall translate as "The Harmony between Theory and Practice in the Science of Engineering." In this admirable thesis, which is still a classic on the subject, he shows that the gulf which had long been supposed to exist between theory and practice, to the detriment of both, is, in fact, a bridge represented by the university professor and student. That is to say, he divides the entire science into three compartments, with pure science at one end, applied science at the other, and the student and professor in the middle maintaining communication between the two ends and deriving from the results of the theoretical research by the physicist those rules and formulæ which are the working tools of the practical engineer. How well he exemplified this interpretation of his new duties I hope to show, and how well he was qualified to pass judgment in the matter we see in the astounding fact that during his own short lifetime he actually occupied with distinction all three positions in this chain. First, a youth spent in practical engineering, then a period of brilliant research in pure science, and the evening of his days in the professorial chair laying the educational foundation of the science of engineering as we know it to-day.

Of Rankine's influence as a professor I cannot do better than quote a passage from the address by Professor Barr, who was well qualified to judge:

> "By the systematising of a suitable course of study, the publication of comprehensive and thoroughly scientific text-books, and by the world-wide reputation he had secured by his researches, Rankine may be said to have created the part of Professor of Engineering Science. There is probably no one who is capable of judging of the scope and the soundness of his work and the influence he had in the development of engineering science, who would contest the claim that may still be made for him that he ranks as the greatest Professor of Applied Science who has yet appeared."

Of Rankine's work as an engineer the bookshelves of any engineer of to-day bear silent witness. His text-books on "The Steam Engine," "Applied Mechanics," "Civil Engineering," "Machinery and Millwork," "Ship-building" and "Rules and Tables," may well remain classics as long as the world has need of engineers. He was undoubtedly the most prolific writer of his time, and, indeed, of any time, on engineering subjects, and in many sections he was, in fact, creating the science as he wrote. These books were all written during the years of his professorship in fulfilment of his own definition of the office; but long before that his pen had been busy, and from 1842 onwards the "Transactions" of the Institution of Civil Engineers, the Royal Society, the Royal Society of Edinburgh, the British Association, the Institution of Engineers and Shipbuilders in Scotland, of which he was the first President, and the Philosophical Society of Glasgow contain many papers contributed by him, while other contributions to the pages of THE ENGINEER and other technical journals were of almost weekly occurrence. Many of his earlier papers on engineering subjects were, he records, suggested and inspired by his father, and in some cases were the result of their joint researches. Of these latter one of the most important is also one of the earliest, namely, a paper read before the Institution of Civil Engineers in 1843 on joining the Institution as an associate at the age of twenty-three, entitled, "On the Causes of the Unexpected Breakage of the Journals of Railway Axles," in which he disproved the then generally accepted theory of spontaneous crystallisation of wrought iron, and drew attention for the first time to the importance of continuity in form and fibre.

Many of these writings of Rankine's may appear of little interest to-day, but we have to remember that he lived in the days of primitive engineering, when things were not so obvious as they may now appear. The preceding century of great inventions, commencing with the invention of the separate condenser for the steam engine by James Watt—an invention which started within the walls of the old College in the High-street, where Watt worked as an instrument-maker—was just giving birth to the industrial revolution of the Victorian era. The introduction of cheap power in the form of the steam engine and its application to modes of transport and to manufacturing processes previously carried out by human or animal labour, was creating a demand for new and improved machines of all kinds, and also for improved roads, railways, bridges, canals, lighthouses, and other civil engineering works to ensure cheaper and safer transit. This tremendous increase in the industry of the nation was actually adding millions to the population of the country, and was concentrating that population into specialised industrial areas, thus creating all sorts of further problems in transport, housing, water supply, and conservancy. The few engineers of the day had their hands full, and were far too busy doing things to write about what they were doing for the education of others. What was needed above all things was a man with the ability to write, and with the practical experience of the problems that confronted the engineer, to codify and standardise the theory and practice of engineering in a form that would not only satisfy the needs of the day for standard works of reference, but would also anticipate the educational needs of the morrow. And the man was found in Rankine. The task was enormous, and the completeness with which he performed it in such a short period of time fills us with admiration bordering on amazement.

To the engineer of to-day, and particularly to the student of engineering, Rankine is best known by his text-books and by several practical methods which are called by his name. I have referred to Rankine's method of laying out railway curves, but there is also his well-known method of studying the stresses in framed structures by the use of reciprocal diagrams, a method later extended and simplified by Maxwell. Rankine's methods of calculating earth pressures, the strength of struts and columns, the stresses in masonry dams, the stability of chimneys, &c., are all well known and still in use. But, in addition to these better-known works and methods which imprint Rankine's name on the memory of the present-day student, much of our modern knowledge and practice is derived in less obvious ways from Rankine's pioneer work. In this connection there is an eloquent passage in Professor Barr's address which I think I would do well to quote:

> "Many of the results of his labour are within the grasp of men of meagre mathematical attainments, and not a few of them are now the common property of engineers and others who may not even know to whom they owe them, or realise that familiar and almost primitive as they may seem to-day, they had to be quarried out of the formless mass of the unknown by the patient labour of a master craftsman."

And now I pass to Rankine's work as a physicist, though, even in dealing with this phase of his work it is impossible to leave engineering out of the picture, for much of Rankine's labour in physics had a far-reaching effect in the spheres of practical engineering, shipbuilding, and naval architecture.

What I have said of Rankine's early upbringing must have appeared to some of the older members of my audience as strikingly similar to a record of the boyhood of that other great physicist of the last century, his contemporary and colleague, Lord Kelvin. The absence of regular schooling, the early training at home, the predominance in that training of the Bible on one hand and Newton's "Principia" on the other, figure in the lives of both. Both were strongly mathematical, though neither was a pure mathematician. A distinguished pure mathematician has confessed to me that he was never happy until he had resolved a problem into symbolic form, and that he found his pleasure in dealing with symbols and not with the physical facts which they represented. In dealing with physical problems, indeed, some pure mathematicians have not been too careful about the assumptions made in order to reduce the problem to a mathematical equation. The mathematical physicist, on the other hand, is a physicist first and last, using mathematics solely as a tool, and being scrupulously careful of any assumptions which he may have to make in order to employ the tool. If the assumptions cannot be justified, then the tool is useless, and he must find another in graphical or other methods of dealing with the problem. Kelvin and Rankine were both essentially mathematical physicists.

### MOLECULAR PHYSICS.

The experimental researches of Regnault on the relationship between the pressure, temperature, and specific volume of steam and other vapours, those on the liquefaction of gases by Faraday, Andrews, and many others, the demonstration by La Tour of the existence of a critical temperature at which it is impossible to detect when the change from gas to liquid takes place, and the anomalous changes in the coefficient of expansion of the liquid as this critical temperature is approached, all pointed to a continuity between the liquid and gaseous states, and provided material for speculative theories on the molecular constitution of matter. Davy, Joule, Kelvin, Helmholtz, Maxwell and Rankine all took part in this search for a theory which would satisfactorily explain the facts then known. It was practically certain that if such a theory could be found, it would lead to further important discoveries.

Rankine's theory, published in 1850, plays such a prominent part in much of his later work, and has such a direct bearing on recent discoveries in molecular physics, that I make no excuse for quoting the basis of the theory in his own words:

> "ON THE HYPOTHESIS OF MOLECULAR VORTICES."
>
> "The fundamental assumptions are the following:—
>
> "*First.*—That each atom of matter consists of a nucleus or central physical point, enveloped by an elastic atmosphere, which is retained in its position by forces attractive towards the nucleus or centre.
>
> "*Second.*—That the elasticity due to heat arises from the centrifugal force of revolutions or oscillations among the particles of the atomic atmospheres; so that quantity of heat is the *vis viva* of these revolutions or oscillations.
>
> "This supposition appears to have been first definitely stated by Sir Humphry Davy. It has been supported by Joule, whose valuable experiments to establish the convertibility of heat and mechanical power are well known. So far as I am aware, however, its consequences have not hitherto been mathematically developed.
>
> "*Third.*—That the medium which transmits light and radiant heat consists of the nuclei of the atoms, vibrating independently, or almost independently, of their atmospheres, so that the absorption of light and of radiant heat is the transference of motion from the nuclei to their atmospheres; and the emission of light and of radiant heat the transference of motion from the atmospheres to their nuclei."

Rankine developed this theory at considerable length in a series of abstruse mathematical papers, wherein he points out that no matter whether the mental picture of the nature of the nucleus and surrounding atmosphere be right or wrong, the conclusions must hold for any molecular structure involving the same fundamental laws of attraction.

At the close of the nineteenth century Sir J. J. Thomson and his followers began an experimental research into the constitution of the atom, and thanks mainly to the researches of Lord Rutherford, it has now been established that the atom is built up of negatively charged electrons and positively charged protons, and according to a widely accepted theory the proton is the nucleus or sun of an infinitesimal celestial system and the electrons are the planets whirling round it. Such a system would seem to satisfy the laws assumed by Rankine as applying to his material atom, and if so, Rankine's conclusions ought to apply to this modern theory. The further investigation of this connection might form a suggestive line of research for some young mathematical physicist.

Rankine's theory with its nucleus and atmosphere is

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* An oration delivered at Glasgow University on June 15th, 1932, at a meeting in Commemoration of Benefactors. Reprinted by kind permission of the Vice-Chancellor, Principal R. S. Rait.

† Our own obituary notice, published in our issue of December 27th, 1872, occupied less than two dozen lines. "Sad news," we wrote, "is best told briefly." For many years Rankine had been a frequent writer in our columns, so much so that in concluding our obituary notice, we referred to him as "at once one of the most valued and valuable contributors on our staff," and spoke of his death as leaving in our pages a blank which we should not easily fill.—ED. THE E.

‡ Our obituary notice attributed his death to apoplexy.—ED. THE E.

scarcely mentioned in the text-books on physics, whereas the vortex atom theory of Helmholtz and Kelvin, according to which the atom is a mode of motion in the ether akin to a smoke ring in the air, is generally described. It appears now, however, that Rankine's theory was much nearer the truth.

### Elasticity.

Rankine's work on elasticity, which really started with the application of his system of molecular vortices to gases, was extended in a series of mathematical papers dealing with "The Laws of Elasticity of Solid Bodies," "Axes of Elasticity and Crystalline Forms." "The Vibration of Polarised Light," "General View of an Oscillatory Theory of Light," and "The Velocity of Sound in Liquid and Solid Bodies of Limited Dimensions, especially along Prismatic Masses of Liquid." I do not propose to deal at any length with this section of his work, but the mere recital of the titles of these highly technical papers will serve to show the wide range of subjects in which Rankine was interested.

### Thermodynamics.

No one present here to-day will remember the time when conservation of energy was not one of the fundamentals, if not the fundamental principle, underlying all physical phenomena, or the famous discussion as to whether the kinetic energy of a body is represented by $mv^2$, or by $\frac{1}{2}\ mv^2$, a point which could be settled by any schoolboy of to-day. Having been brought up "in the faith," we find it difficult to imagine the state of mind of the scientist before the "faith" existed.

In Newton's time heat was regarded as a kind of ethereal substance called caloric, which bodies could absorb to produce a rise in temperature, while the heat evolved by friction between two bodies was regarded as due to a reduction in the absorptive powers of the bodies which caused caloric to be squeezed out. The classic researches at the end of the eighteenth century by Count Rumford on the heat generated in the boring of cannon, and by Sir Humphry Davy on the melting of ice by friction, killed the caloric theory and introduced the idea that heat was a mode of motion of some sort. The researches of Joule, Kelvin, Clausius, and Helmholtz in the 'forties of last century definitely established the conservation of energy and introduced the word "energy" for the first time. It is significant that in his famous essay in 1848, "Die Erhaltung der Kraft," Helmholtz does not use the word "energie," although the essay deals with the conservation of energy. The indestructibility of energy became the first law of thermodynamics.

Another great law of nature discovered in Rankine's time and to which he contributed greatly, now known as the second law of thermodynamics, is of even greater importance than the first law, in that it has contributed much more to further discoveries.

The first law merely states that the total energy is constant, that we cannot do work without the expenditure of energy, or that perpetual motion is impossible.

The second law states that even with inexhaustible sources of heat in the air, earth and sea, it is impossible to have perpetual motion without a condenser or sink of heat at lower temperature, into which some of the heat abstracted from the inexhaustible source must be exhausted before the heat in the source can be available. A parallel case in dynamics is that of a water turbine driven by water from the sea and exhausting down a mine shaft. Sooner or later the mine shaft will become full of water and the turbine will cease to function, and the sea will no longer be a source of power. So it is also with the heat in the sea—it cannot be used in heat engines unless there is a sink of heat at lower temperature than that of the sea.

The second law, however, has a much wider application in nature as it provides a means of measuring the stability of any natural state, and indicates the direction in which all natural changes will take place.

The foundation of this law was lying dormant in an essay written by Carnot in 1824 relating to heat engines, wherein we have an example of one of the wonders of science—that a discovery in a limited field may prove to have wide ramifications in all processes of nature. In his essay on "Heat Engines," Carnot devised a cycle of operations for the working substance, since known as Carnot's cycle, which he proved to be the ideal of efficiency to be aimed at by engineers in any heat engine. Viewed simply as an ideal of accuracy the Carnot cycle was a great discovery, but no one at that time could have had any idea of the colossal discoveries to which it would lead. These discoveries arose from Carnot pointing out two facts: first, that the efficiency of his ideal engine depends only upon the two temperatures at which heat is taken in and exhausted, and secondly, that this efficiency is independent of the working substance.

I have already indicated that physicists of the first half of the nineteenth century were groping in the dark for a mechanical hypothesis of the constitution of the molecule which would explain some, if not all, of the complex phenomena of nature, because further progress in physics seemed impossible without it. The great importance which has gradually become attached to Carnot's discovery by physicists is due to the fact that it provides a means for studying molecular physics in the bulk without any hypothesis as to the constitution of the molecule, and also provides a measure of stability of any condition in nature. The secret lies in the fact that the efficiency of the Carnot cycle is independent of the working substance, so that by putting different substances, or the same substance in different conditions, through a Carnot cycle and writing down the efficiency, one cannot fail to make a discovery with respect to the substance.

It is strange that this fact was overlooked for over twenty years; in fact, Carnot's essay was forgotten for over ten years and Glasgow University took a prominent part in its exhumation and republication. Clapeyron, in 1834, and Lewis Gordon, Rankine's predecessor, in 1842, drew attention to the essay; then Kelvin, Clausius, Helmholtz, James Thomson and Rankine all contributed to its application and advancement. Kelvin derived from it the variation of latent heat with temperature, an absolute scale of temperature independent of any material, and he also applied it to thermo-electricity. Helmholtz worked out the temperature coefficient of the E.M.F. of an electric battery; James Thomson derived the effect of pressure on the melting point of ice. Rankine became a disciple of Carnot, and wrote voluminously on the application of the Carnot cycle to heat engines of different types, and in his essay on "Energetics," he applied it to his earlier theory of molecular vortices with some remarkable results.

It is strange that no physicist of Rankine's time applied the Carnot cycle to chemical combinations by taking as the working substance a mixture of two elements which combine. Had they done so the development of modern chemistry would have been greatly accelerated. A remarkable paper by Willard Gibbs in 1876 led the way, and the work of Clausius, van t'Hoff, Helmholtz, Planck and Nernst laid the foundations of modern thermodynamic chemistry, which is based upon the stability of a combination as determined by the Carnot cycle. The test of stability is made by what is known as Carnot's function, to which Clausius gave the name of entropy, and in any stable state the entropy must be a maximum.

It is well known that at ordinary temperatures hydrogen and oxygen combine with explosive force to form water, yet the spectroscope shows us that at the temperature of the sun water dissociates into hydrogen and oxygen. The Carnot cycle applied to this problem explains the apparent anomaly, and shows us that at every temperature there is a definite stable mixture of hydrogen, oxygen and water, the mixture varying with the temperature.

In his essay on "Energetics," Rankine showed that the second law of thermodynamics is only a particular case of a still wider law applicable to other sciences in which energy is stored in bodies in other forms than that of heat, such as magnetism, electricity, light, &c. It would be easy to make a claim for Rankine's foresight in this respect and to consider this wider law as the second law of energy, or Rankine's law, but such a claim might, in the light of future progress, prove to be extravagant. For nearly forty years after Rankine's essay no such development as was conceived by him took place, and entropy was considered to apply only to thermodynamics. In the wider application Rankine called the two factors of energy corresponding to temperature and entropy the metabatic and metamorphic functions. The first step along the path indicated by Rankine was not taken until 1900, when Planck applied entropy to electromagnetic theory, and gave to it a new interpretation and physical meaning. In the 'nineties of last century the Reichsanstalt, which is the National Physical Laboratory of Germany, was engaged in the investigation of the distribution of energy in the spectrum of incandescent bodies, and after years of work obtained beautiful curves giving the energy in the spectrum of a luminous black body and its variation with temperature. Professor Wien then derived an equation which represented the whole family of curves almost entirely within the limits of experimental error. Professor Planck then tackled the problem theoretically, and searched for a function in the radiation which would represent the entropy. He pointed out that the entropy in any state is simply a measure of the probability of that state, the logarithm of the probability being proportional to the entropy. The simplest function which he found gave him Wien's equation, but he could only derive the function by assuming that energy is not infinitely divisible, but that there must be a fundamental indivisible unit, which he called a quantum. He thus discovered the quantum theory, and the quantum, which, in at least one theory, is now known as the electron, has revolutionised modern physics. Incidentally, Planck introduced a function which simplified his equations considerably and brought them into line with those of thermodynamics, and this function he called the temperature of the radiation. It is probable that further developments on these lines will follow in other sciences, throwing light upon our ignorance, and that by similar arbitrary definitions of temperature the second law of thermodynamics may survive as a general law applicable to all branches of physical science. It will obviously be more convenient if so arranged than to have different names for the factors of energy in different sciences.

It is not obvious why the entropy should be connected with probability, since the laws of probabilty only apply to incidents or units when repeated millions of times, but in the particular case of the partition of energy in the spectrum, Planck points out that if we consider only a very narrow band of the spectrum, one millionth of the width of the visible spectrum, there are still five hundred million frequencies in it among which the energy has to be distributed. The connection between a stable distribution and probability thus becomes clear.

Rankine's contribution to thermodynamics Professor Tait described as his greatest work. He laid the foundation of the mathematical science as it is known to-day, he applied the second law to heat engines of all kinds, steam engines, air engines and explosive engines, while in the steam engine he introduced the cycle now known as the Rankine-Clausius cycle, which is used as the ideal for engines and refrigerators employing vapours as the working substance, and he pointed out that this law is only a particular case of a wider law applicable to all sciences.

The final state to which the Universe is drifting was a subject which interested both Kelvin and Rankine. Kelvin pictured all energy being gradually transferred to its lowest form of heat and dissipated by radiation and conduction until the whole universe would be at one temperature, and that a very low one. Life, of course, would cease long before that final state could be attained—truly a pessimistic picture. Rankine was much more optimistic, and pointed out that if the outer confines of space were perfect reflectors the radiation would be concentrated in foci, and that any celestial body drifting into one of these foci would soon be raised again to a temperature sufficient to start its life over again as a new star or sun. Hence, the present type of distribution of energy in our celestial system might be repeated indefinitely by cyclical processes. The same idea has recently been advanced by Sir James Jeans on a similar theory of radiation concentrated in foci, but with the difference that Jeans accounts for the concentration, not by reflection from the outer confines of space, but by Einstein's curvature of space. We are, therefore, free to adopt whichever theory best suits our individual tastes and aspirations.

### Hydrodynamics.

Rankine's work on hydrodynamics has been of the greatest value to engineers and naval architects. The mathematical theory of hydrodynamics is so very abstruse and so limited in its application to practical problems that it is repugnant to most practical men as the physics of the problem is lost in a maze of symbols and equations. Rankine showed how wave motion in deep water, which the naval architect must understand, can be studied from the physical standpoint and with only the simplest mathematical tools.

Incidentally, Glasgow University, and the Professor of Engineering in particular, owes much to this part of Rankine's work. He was a man of great geniality and many friends, and in his period as Professor in Glasgow two of his closest friends were James Napier and John Elder, both of whose names are still household words on the Clyde, and, in fact, throughout the whole world of shipping. Rankine seems to have helped both of them in many problems of shipbuilding and construction, and in all probability he was able to draw on their experience in the writing of his book on shipbuilding. His salary as Professor was only £275 a year, but when John Elder died and Rankine commemorated their close friendship by writing his biography, which was published in 1872, Mrs. Elder, as a memorial to her late husband and as a tribute to his biographer and friend, handed over to the University the much-needed funds for the further and adequate endowment of the Chair of Civil Engineering and Mechanics.

When confronted with a problem, evidently set by John Elder, of determining the best form of streamlines for a ship's hull, Rankine made a most ingenious use of Kelvin's artifice, used in problems of heat conduction, of combining sources and sinks by purely geometrical methods. In the two-dimensional problem he combines a source with a sink of equal magnitude and obtains lines of flow like the magnetic lines round a bar magnet. Combining these with a parallel flow he obtains by a graphic process one streamline, which is an oval figure, and all outside it are ship-shape lines. He shows how the dimensions of the oval may be varied, and under what conditions a stream-line due to one oval may be chosen for the forward part of a ship and that from another oval for the after part. This is an excellent example of scientific use of the imagination to solve a difficult practical problem by purely hypothetical conceptions.

Another problem which was set him by James Napier was the estimation of the power required to drive a ship of given lines at a given speed with no previous knowledge derived from experience or experiments with models. This seemingly impossible conundrum he tackled in a very original way, which may be briefly described as follows. Imagine the ship moving forward at the required speed. Imagine now that the ship is lifted bodily out of the water, but that the cavity in which it formerly rested does not fill up but continues to move forward as a wave depression. In order to do so the velocity of each particle of this wave surface must obey the laws of wave motion and can be easily ascertained. This velocity constitutes a rubbing velocity against the ship's surface, and the total power so lost in friction is thus obtained. The results obtained by this ingenious method were so good that Napier objected to its publication as he wanted to keep a monopoly of the method. Rankine protested, but finally compromised by publishing it in the *Philosophical Magazine* in the form of an anagram, which no one seems to have been able to solve until the answer was found in his papers after his death.

In Rankine's day the speeds of ships were generally low and the power was nearly all consumed in overcoming friction. The increase of speed in recent years has greatly increased the wave resistance of a ship, due to the systems of waves in echelon diverging from both bow and stern, and the system of transverse waves between them which makes the wave resistance a periodic function of the ship's length and of the speed. Our present knowledge of these complicated phenomena is mostly due to the work of W. and R. E. Froude, and the whole science is now based on model experiments with apparatus which was not available in Rankine's day.

Of Rankine the man, a study of his bust in the possession of the University gives a much better idea than any I could possibly convey in words. An old friend and former colleague of mine, Professor Waghorn, who is now eighty-four years of age, remembers Rankine coming to the Royal School of Naval Architecture at South Kensington to examine the students of his year. He describes Rankine as looking like a farmer, and although all the students were very much afraid of him as an examiner, they were more than surprised by the simplicity of the papers which he set them.

I referred earlier to Rankine's study of music as a boy. Therein he seems to have acquired the same proficiency which he showed in more serious walks of life, and the lighter side of even technical matters he committed to songs and verses, some of which have since been collected and published. At the dinners of the "Red Lions," following the annual meetings of the British Association, he was in great demand, and in 1871, when the Association met in Edinburgh, he was elected Lion King. None of these convivial evenings was complete until Rankine had been called to the piano, where he would sit and sing, to his own accompaniment, a song almost always composed by himself, and generally a humorous skit on some scientific question of the day.

To conclude this address, I think I cannot do better than quote a few sentences written by one who knew Rankine intimately. In his preface to Rankine's "Miscellaneous Scientific Papers," the late Professor Tait, of Edinburgh, writes:

> "Of the man himself it is not easy to speak in terms which, to a stranger, would appear unexaggerated. His appearance was striking and prepossessing in the extreme, and his courtesy resembled almost that of a gentleman of the old school. . . . His conversation was always interesting, and embraced with equal seeming ease all topics, however various. He had the still rare qualification of being a good listener also. The evident interest which he took in all that was said to him had a most reassuring effect on the speaker; and he could turn without apparent mental effort from the prattle of young children to the most formidable statement of new results in mathematical or physical science. . . . He was ambitious, but he was the very soul of honour in respect to giving all credit to others, and in never attempting in anything, small or great, to go a hairbreadth beyond the line of right as to his own claims. He showed a particularly good and generous temper in cases of difference on scientific questions—a temper which proved the true metal, unalloyed by any mean quality."

# L.N.E.R.—TANK ENGINE WITH BOOSTER

MR. H. N. GRESLEY, LONDON, ENGINEER

## L.N.E.R. Tank Engine with Booster.

ENGINE No. 6171, which is one of four used at the Wath Concentration Yard of the L.N.E. Railway for pushing wagons over the gravitation hump, and originally put into service in 1907, has been rebuilt at Gorton to the requirements of Mr. H. N. Gresley, chief mechanical engineer of the L.N.E.R., and fitted with a reversible booster. The engine has three 18in. by 26in. high-pressure cylinders, the centre cylinder driving on to the second pair of coupled wheels, the outside cylinders driving on to the third pair of coupled wheels. The driving wheels are 4ft. 8in. in diameter, but the original bogie wheels, 3ft. 6in. in diameter, have been replaced by 3ft. 2in. wheels for the booster. The weight on the bogie is now 28 tons 15 cwt., as against 23 tons 8 cwt. before conversion, the weight on the coupled wheels being reduced, the total weight of the booster engine being 104 tons 9 cwt., as compared with the original 99 tons. The boiler has been given a superheater.

The booster, which was manufactured by J. Stone and Co., Ltd., Deptford, communicates its power to the leading bogie axle through gears, the trailing wheels of the bogie being coupled to the leading wheels by side rods. As these engines only travel at low speeds the gear ratio of the booster is 1 : 2·71. The booster is steam controlled and can be cut in either to run forward or backward as may be required.

The tractive power of the engine at 85 per cent. boiler pressure, without the booster, is 34,523 lb., and with the booster in operation this is increased by 12,373 lb., making the total tractive effort 46,896 lb. The ratio, adhesive weight : tractive effort of the booster is 5·2 and of the engine itself 4·9, as before conversion.

A diagrammatic lay-out of the booster and its connections is reproduced in the drawing.

The sequence of operation as indicated on the diagram is as follows :—Boiler steam valve 1 is opened and steam admitted through pipe 2 to the combined control steam valve 3 and preliminary throttle valve 4. When steam valve 3 is opened it allows steam to pass through pipe 5 to the duplex reverse lever pilot valve 6.

To operate the booster in forward gear the locomotive reversing lever 7, which is coupled to latch lifting lever 8, is moved to the forward position, causing latch lifting lever 8 to raise latch 9. This movement unseats valve 10 and seats valve 11, allowing the steam to flow past valve 10, through pipe 12, to the preliminary throttle valve 4, and at the same time steam flows through pipe 13 to the underside of clutch cylinder piston 15 in clutch cylinder 16 and to the rocker stop cylinder 14.

On the opening of the preliminary throttle valve 4 the steam passes through choke 17 and pipe 18 into the main booster steam pipe 19, allowing the booster to revolve slowly and the gears to mesh.

When steam enters pipe 13, ball valve 20 is forced on to its opposite seat, thereby isolating the pipe to the backward side of the duplex reversing lever pilot valve 6.

When the piston 15 in clutch cylinder 16 has moved upwards and the gears have meshed it uncovers steam port 21 and allows steam to flow through pipe 22 to the main throttle valve operating cylinder 23, which opens booster main throttle valve 24 and admits steam at full boiler pressure from the locomotive superheater through main stop valve 25 into the main booster steam pipe 19.

When steam pressure has built up in main booster steam pipe 19, which is fitted with a non-return valve 26, steam through pipe 27 enters the delay action valve 28, which controls the booster cylinder relief cock operating cylinder 29.

The steam on entering the delay action valve 28 causes the piston 30 to close the exhaust valve 31. The steam then passes slowly through needle valve 32 and pipe 33 and slowly builds up pressure behind the piston of cylinder relief cock operating cylinder 29.

When sufficient pressure to overcome the resistance of spring 34 has been built up the piston moves in the direction of arrow and allows the steam in the booster cylinders automatically to shut off the cylinder drain cocks 35 and 36.

A small hole 37 is made in the preliminary throttle valve 4 to permit a small amount of steam being fed to the booster cylinders, in order to keep them warm in cold weather. To run the booster engine out of gear the idling valve 38 shown in the duplex reversing lever pilot valve 6 is turned, thus isolating the passage to the inlet valves 10 and 39. This allows steam to flow direct through pipe 12 to the preliminary throttle valve 4.

On the opening of the preliminary throttle valve 4 the steam passes through choke 17 and pipe 18 into the main booster steam pipe 19, causing the booster to revolve.

The exhaust steam from the booster cylinder passes through pipe 40 to the steam separator 41 and thence through pipe 42 into an annular space in the locomotive blast pipe 43 and to atmosphere in the ordinary way.

Valve 44 in the steam separator 41, which is balanced by counterweight 45, is operated by the weight of the trapped moisture in the chamber, the moisture being allowed to drain through the opening 46.

To reverse the booster the locomotive reversing lever 7 is moved to the backward position. This causes latch lifting lever 8 to raise latch 47, which closes valve 48 and opens valve 39, allowing steam to force ball valve 20 on to its opposite seat and flow through pipe 12 to the preliminary throttle valve 4, which opens as for forward gear and supplies steam through choke 17 and pipes 18 and 19 to revolve booster slowly. At the same time, steam flows through pipe 49, closes ball valve 50 to prevent steam entering the underside, and enters the topside of piston 15 in clutch cylinder 16. The piston 15 is depressed and the slowly revolving booster gears mesh.

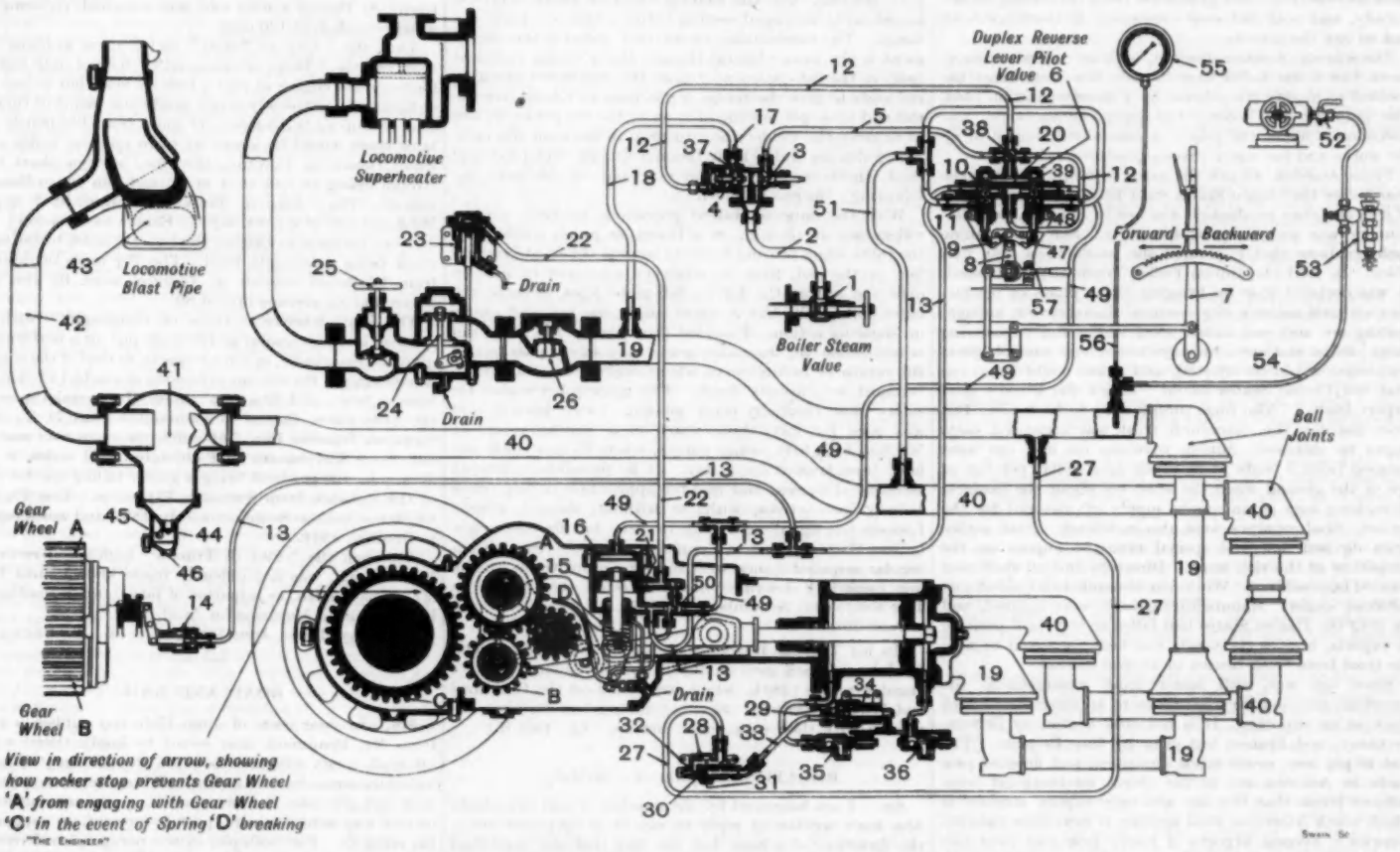
The booster cylinder drain cocks 35 and 36 are operated exactly as in forward gear.

Exhaust steam from the duplex reverse lever pilot valve 6 flows through pipe 51 into the booster exhaust pipe 40 and then through steam separator 41, pipe 42, and blast pipe 43 to atmosphere.

The booster engine valves and cylinders are lubricated by means of a sight-feed lubricator 53, to which steam is supplied from combination stand on boiler, through steam cock 52, and oil is fed into the main booster steam pipe 19 by pipe 54.

The pressure gauge 55 is connected by pipe 56 to the booster main steam pipe 19.

A clutch 57 is fitted to throw the latch lifting lever 8


Duplex Reverse Lever Pilot Valve 6
Locomotive Superheater
Locomotive Blast Pipe
Drain
Boiler Steam Valve
Forward
Backward
Ball Joints
Gear Wheel A
Gear Wheel B
View in direction of arrow, showing how rocker stop prevents Gear Wheel 'A' from engaging with Gear Wheel 'C' in the event of Spring 'D' breaking
"THE ENGINEER"

DIAGRAMMATIC ARRANGEMENT OF BOOSTER AND CONNECTIONS

## Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### STEEL TRADE RATIONALISATION.

SIR,—Efficiency is an elastic word, depending on circumstances. It has long been fashionable to assert that British steel plants are not efficient; but, without export bounties or subsidies, and whilst carrying the highest rates and taxes in the world, and paying the highest wages in Europe, the British steel industry exports steel and steel products of a value equal to that of any two foreign industries put together. However, the politicians who have long denied British industry fair conditions of competition have constantly declared that this industry ought to be "rationalised" or reorganised.

Rationalisation is like medicine. It may be good in small doses and in certain cases, but bad if taken by the

bucketful and in all cases. In Germany they have carried rationalisation to extreme degrees in coal and iron and steel industries. With what result? The object was to reduce costs. Costs have been increased. When rationalisation had been fully carried out in the mining industry of Germany the actual mining costs of various grades of coal and coke ranged from 3s. to 6s. per ton higher than the corresponding costs in Britain. The official and fully attested mining statistics proved that. Millions of tons of British fuel have been sold in Germany—some of them as far inland as Berlin—at prices lower than German fuel prices, notwithstanding a special bounty on the German coal and coke competing against British. Before rationalisation a syndicate levy on output of 1 mark per ton and an export bounty of about 2 marks were considered sufficient for competitive purposes. Since full rationalisation the German coal levy has been advanced to more than 3 marks per ton and German coal competing against British coal has had to be bounty-fed to the tune of 6 marks per ton. The chairman of the German Coalowners' Association has openly admitted that rationalisation has failed, for the extra cost of machinery and re-equipments and interests on extra capital have much more than outweighed the saving on manual labour.

Dr. Reichert, chief manager of the German Iron and Steel Association, candidly confessed about four years ago that rationalisation had failed in the German iron and steel industry. He stated that it had caused "a wrong investment of capital, and had led to 'uneconomic costs.'" As a matter of fact, when British steel prices had been got down to a level only 13 per cent. above the 1913 level, German steel prices were 28 per cent. higher. As with coal, so with steel, extra levies have had to be made on output in order that exports might be maintained by means of extra bounties (as much as 80 marks per ton has been paid in respect of German steel boiler tubes to enable them to compete in neutral markets) since rationalisation has been effected. In other words, actual costs have increased or been prevented from decreasing economically, and coal and steel consumers in Germany have had to pay the penalty.

The scheme of rationalisation, with its central management, has so far failed that the German Steel Trust has decided to modify the scheme by a decentralisation plan. The industry has become top-heavy, cumbersome, and uneconomic under the policy of centralised control of all the works and the many various products.

From America we get the same lesson. In 1900, the year before the United States Steel Trust was formed, cost of iron and steel production was low in America, and that country was second in steel exports. She was making such headway that it seemed she would soon take first place. In 1901 the Billion Dollar Trust was established. It was declared that by bringing every phase of production and sale under a single central management, amalgamating ore and coal mines, steel works and engineering shops, ships and even railways under one control, great economies would be effected, and prices could be so cut that the United States would "annex the world's steel export trade." Also huge profits were to be made. But from the day the mammoth trust was organised costs began to increase. Mining royalties on iron ore were jumped from 7 cents to as much as a dollar per ton of ore in the ground when the trust set about the business of making sure of an ample supply of material for the future. Coal royalties were also increased. State authorities devised new and special taxes to impose on the properties of the rich trust. Directors and all staff men wanted huge salaries. Workmen demanded and got almost fabulous wages. Manufacturing costs were inflated, and by 1913 the United States had fallen to the third position in exports, besides the tariffs had been increased to save the trust from being beaten in its own market.

Since the war, still under trust management, the American steel industry has fallen to an insignificant fifth place as an exporter. It is not only beaten by Britain, Germany, and France, but even by tiny Belgium. The cost of pig iron, crude steel, semi-steel, and finished products in America are so far above international competitive levels that the one and only export market in which much American steel appears is next-door Canada. America's oversea exports of heavy iron and steel and products amount to but a fraction of those of the much smaller European countries.

To put it shortly, that sort of reorganisation or rationalisation which British coalowners and steel makers are advised to adopt has completely failed in Germany and the United States. Mere bigness is not strength. Huge combines are apt to get as clumsy and costly as Government Departments.

E. T. GOOD.

Sheffield, June 13th.

## FLANGED WHEEL ON RAILWAYS.

SIR,—Since Trevithick in 1804 gave the world the steam railway, the flanged wheel has been, and will always inevitably continue to be, the source of many grave and costly disasters from derailments on curves. The railways, always being far safer and pleasanter, and especially so for pedestrians, than the public roads, accidents upon them are insignificant by the side of the daily death toll on the people's roads, and we can, therefore, afford to criticise railways if the intention is for their betterment.

The flanged wheel is cheap, simple, and even reliable on easy curves; but, every now and then, the rail-joint gives, and the flange finds an abutting rail end on which to surmount and override the outside rail on curves whenever the speed is in excess of regulation limits, and such inattention to safety by drivers happens occasionally while it occurs all the day through on the public roads, where the insurance company relieves the care-free driver of all responsibility for the deaths which ensue.

But, at present, with the over-ruling speed mania of a sporting public, to which time-economy has otherwise no interest, an all-round increase of speeds, on railways, in general, is commercially desirable in order to attract the public from the greater speed thrills on the high roads, and a safer form of guide than the flange would permit increased average speeds with safety. The locomotive power available for over 90 m.p.h. and with average start-to-stop speeds as high as those on the G.W.R. trip on June 6th, was amply demonstrated in 1907 (twenty-six years ago) with compound locomotives developing 27 horse-power per ton of engine on 16 tons axle-loads. Those locomotives on level lines might now average 90 to 100 m.p.h., but the rails then could not be trusted, and for the good reasons given then by the companies; so average speeds little above normal were subsequently adopted for their regular trains.

The weakest part of a railway track is well known to be the rail joint, which, on sharp curves, cedes to the thrust of the flange prior to a derailment; hence, the limited speed regulations on sharp-curved rails. The causes of wear in fish-plate joints are known. "They may bend or become distorted and break. The outer rail on curves ultimately fails by wearing away of the head, with the continued shearing action of the flanges that are thrust against it, and the head of the inside rail is ground off," because both wheels are rigid on one axle, and the lineal speed on the two rails is different. There is, consequently, wear, and more locomotive power is required to overcome the friction. To reduce this friction on curves, it was, some years ago, common to provide grease or steam lubricators on the flanges. On the "Marsillon" trussed-rail tramways of Paris one flanged wheel ran loose on the axle and so decreased the power required.

At high speed every passing flange batters the rail joint laterally, and the leading wheel on sharp curves is forced on to its coned section between the tread and the flange. The determining factor that initiates the derailment is the heavy lateral thrust, which causes sufficient twist on the fish-plates to enable the disaligned abutting rail ends to give the flange a purchase to climb over the rail and to so get outside of it on to the sleeper ends, and in causing the inside wheel to drop in between the rails. The following axles then become unduly weighted and their wheels may break that rail joint, or the next one following; the rest is known.

With the same conditions prevailing, laterally guiding rollers, set at 45 deg., on a Bissel, or pony, truck, with the roller edges bearing squarely against the inside vertical face of the rail, have no tendency whatever to ride up over the rail at the forced fish-plate joint, because the outer roller rolls like a wheel inside the rail and exerts no shearing action. Provided the bulge of the outer rail is not excessive, the roller guide may safely pass out of the return or tailing curve where engines, as at Leighton Buzzard, &c., usually derail. This guide-roller makes for safety more than any other guiding device known, and was used for forty-three years on a railway gauge of 5ft. 8in. with 81ft. radius curves, where flanges could not have been trusted for a day. It is, therefore, a proved mechanical success and free for application to any other railway locomotives, with, or without, flanged wheels. Like electric signalling, it adds to cost; but the cost might be less than the cost of derailments in one year. From regular acquaintenance with the running of trains on the line named, I described and illustrated this system in THE ENGINEER, November 21st, 1890.

June 20th. CHARLES R. KING.

[In his Thomas Hawksley lecture of November, 1925, Sir John Aspinall gave an illustration of William Prosser's angular wheels (1844), which were tried on the Guildford and Woking Railway. Some of our readers may be conversant with their subsequent history.—ED. THE E.]

## RELATIVITY AND A "HOLE."

SIR,—I am honoured by the number of correspondents who have written in reply to my little leg-puller about the direction of a hole, but the fact that the published replies all differ would appear sufficient justification for my endeavouring to point out a possible "hole."

"Via Veritas" has gone into the latter very deeply, and in his anxiety to pull me up on the fact that I had not mentioned the feed of the drill, which is as much taken for granted as the drilling machine, has emerged on the wrong axis; in other words, has entirely missed my point.

In spite of his flat contradiction of my statement, the fact remains that when drilling a hole through a revolving shaft, the drill, if unrestrained at its point, will emerge on the axis of the shaft, even though the direction of its feed is not quite co-axial.

The real explanation of this fact is that a drill will endeavour to do the least work and, consequently, will be subject to a radial thrust towards the axis of the shaft.

If the non-axial drill is rigidly supported in its holder, it will drill a conical hole, but if it is unrestrained, it will drill a parallel hole.

A correspondent, Mr. Fellgett, who kindly addressed me direct by post, has drawn attention to the interesting parallel in relation to boring with a bar; assuming the bar is not quite co-axial with the work. If the cutter is fed along the bar you assure a hole being true for direction and position, but cannot guarantee it as to size, whereas if the work is fed over the tool you ensure a hole of the same size throughout, but cannot guarantee it as to its direction.

I must thank "Via Veritas" for the amusement he has given me in his appeal for "the necessity for precision in framing and discussing problems," descending, as he does, to the use of the appalling expression "anti-clockwise." I cannot imagine what objection or antipathy he should have to the direction in which the hands of a clock rotate! I have a suspicion, however, that he means "contra-clockwise," by which I should have understood that he meant in the opposite direction to that in which the hands of a clock move.

With his final remark that the problem had nothing whatever to do with Einstein's theory, I quite concur. I never mentioned Einstein.

RANSOMES AND RAPIER, Ltd.,
R. STANLEY LEWIS, Chief Engineer.

Ipswich, June 20th.

[In answer to Mr. Lewis' first paragraph, we may say that we purposely selected from many letters those that showed some differences.—ED. THE E.]

## GREAT WESTERN SPEEDS.

SIR,—The G.W.R. run on which Mr. Rous-Marten recorded a maximum speed of 102·3 m.p.h. for a quarter of a mile and 100 m.p.h. for half a mile, down the Wellington bank, took place on May 9th, 1904.

The engine which achieved this speed performance was the redoubtable 4–4–0 "City of Truro," now preserved in the York Railway Museum. On the day in question the Ocean Special was hauled as far as Bristol from Millbay, Plymouth (a fraction over 128 miles), by the "City of Truro." From Bristol the train was worked forward by one of the 7ft. 8in. 4–2–2's, "Duke of Connaught," this part of the total journey consisting of 118¼ miles to Paddington.

On leaving Plymouth (Millbay) the train comprised five postal bogie vehicles, viz., four vans at 22 tons each and one sorting carriage at 25 tons, making a total tare weight of 113 tons. The full load was estimated at 148 tons. At Bristol a mail van was detached, reducing the weight (loaded) to 120 tons.

Thus the "City of Truro" had a more arduous task than had the "Duke of Connaught," for not only had the four-coupled engine to pull a heavier load, but it had also to tackle the extremely severe gradients—some of them at 1 in 40—up to Wrangaton, 15 miles from Plymouth, and later there would be about 3½ more miles of collar work from Totnes to Dainton, the line, after a short level stretch, rising at 1 in 89, 1 in 57, and 1 in 40, to Dainton tunnel. The "City of Truro" averaged 62·2 m.p.h., Millbay to Bristol; 64 m.p.h., Exeter to Taunton; and 74 from Taunton to Bristol, the last 44½ miles to the latter point being practically level. The 10¾ miles of downhill from Whiteball summit to Taunton were, by the way, covered at an average rate of 80.

The single-wheeler, "Duke of Connaught," with the reduced load, estimated at 120 tons, put up a performance quite as remarkable, in some respects, as that of the coupled wheel engine. On the run to London it touched 91·8 m.p.h. once or twice, and 90 several times. Its average speed for the 118¼ miles, Bristol to Paddington, was 71·3; from Swindon Transfer Box, 76¾ miles, its mean rate was 78; and from Shrivenham to Paddington, 70¼ miles, it was 80 m.p.h., the gradient being a gently falling one for most of the distance from Swindon, 77¼ miles. This 7ft. 8in. single was built at Swindon in July, 1897, and was scrapped in October, 1914.

Although the "City of Truro's" high-speed record of 102·3 m.p.h. was not officially made known until 1922, Mr. Rous-Marten, as a matter of fact, himself disclosed it in the *Railway Magazine* for April, 1908.

Stevenage, Herts, June 18th. F. W. BREWER.

## ROAD AND RAIL.

SIR,—In your issue of June 17th you publish a letter from Mr. Beaumont that seems to imply there is not, after all, much difference between the efficiency of mechanical transport by road and by rail, but your correspondent does not give any definite reasons, quote any authority, or cite any achievements, past or present, in support of his remarks. For example, in the paragraph referring to the transport of goods by road and rail from London to Leeds he concludes, "taken together tend to equalise the overall efficiency." But the disparity between the true costs of the two methods of transport is even greater than suggested in my letter published in your issue of June 3rd, as a correspondent has pointed out to me that, in addition to the superiority of the railroad itself, three men will take a load of 500 tons whereas many times that number of men would be required to take the same load by motor vehicle on the high road.

Other correspondents have assumed that I am not aware of the recent improvements in pneumatic tires for heavy motor vehicles and the improvement in road surfaces, but they may rest assured that neither pneumatic tires or road surfaces will take away a single pound from the 33,000 lb. raised 1ft. high in one minute, that is, the brake horse-power or work to be done—apart from the tractive effort—which a motor vehicle has to overcome in mounting a steep incline that does not exist on the railroad.

Again, it is obvious the greater the number of vehicles placed upon the roads without rigid organisation, the greater the congestion of traffic and waste of power from running engines while the vehicle stands still. There is no such thing as free mechanical power; every horse-power generated has to be paid for. It is an absolute loss that is ultimately borne by industry in one form or another. E. C. BOWDEN-SMITH, M.I. Mech. E.

London, S.W. 1, June 21st.

## Railway and Road Matters.

In the June issue of the *London and North-Eastern Railway Magazine* a photograph of the erection by the Mitchell Conveyor and Transporter Company, Ltd., of a mechanical coaling plant at York, in which 70 tons of tubular scaffolding is being used, is reproduced.

Speaking at a Poster Exhibition at York on June 6th, Mr. Hornsby, the North-Eastern divisional general manager, L. and N.E.R., said that his company spent £1000 for every day of the year on advertising. This year nearly 200,000 posters of 90 varieties, covering a total area of 280,000,000 square inches of colour, had been produced to advertise North-Eastern resorts alone; 3000 advertisements, covering 5500in., were inserted in 94 newspapers.

The Southern Railway Company's Bill for building a dock at Dover for the accommodation of the proposed train ferry, having passed the House of Commons, has been before a Committee of the House of Lords since June 7th. The main ground for the opposition there was the necessary increase in the coal traffic that will pass over the sea front. On Thursday, the 16th, the Bill was passed on condition that a clause was inserted limiting the quantity of coal so conveyed to 300,000 tons a year.

On Sunday, June 12th, a tank engine was taking two empty carriages from Rochdale to Bacup on the London, Midland and Scottish Railway, when, just after leaving Wardleworth Station, the engine left the rails and fell on its right side. The driver was killed, and at the subsequent inquest on Tuesday, the 14th, evidence was given that there was a latent flaw in the crank axle. In the opinion of Mr. G. N. Shawcross, the mechanical engineer of Horwich, the breakage was an exceptionally unusual one.

On the western district of the Scottish area of the London and North-Eastern Railway, the Collet system of packing sleepers is being employed, with results that show a 50 per cent. increase over hand packing. The plant consists of a four-cylinder petrol unit, driving an electric generator which supplies current to two electric motors which work the packing hammers. The latter are arranged in groups of four, placed over each rail, and both sides of the sleeper can be packed inside and outside of the rails simultaneously. The plant is fixed outside the line, and can be moved about as required by one man.

The motorman concerned in the Hammersmith collision of June 10th told Colonel Trench at the Ministry of Transport inquiry on the 16th that he misread the signal. His brakes were applied by the automatic train stop, but he thought that that was due to a failure of the apparatus. In anticipation of the opening of the extension to Northfields, considerable alterations to signalling have been made at Hammersmith, and during the work there have been cases of unnecessary "tripping" of the automatic stop—all on the safety side—and the motorman thought that this was an instance of that kind.

During the year ended March 31st, 1931, twelve passengers and twenty-five servants were killed in train accidents on the Indian railways, as compared with six passengers and thirty-three servants killed in the corresponding period of 1929–30. In "movement" accidents, 282 servants were killed, as against 343 killed in 1929–30. There were 22,301 accidents of various kinds reported, and these included 80 collisions involving passenger trains, 369 derailments of passenger trains, 53 collisions between light engines, 222 collisions between goods trains, and 4176 derailments not involving passenger trains.

The Ministry of Transport Railway Statistics for March, which were noted herein on June 17th, also gave the results for the first three months of the present year. They show that compared with the corresponding period of 1931 the number of passenger journeys decreased by 3·0 per cent. and the receipts therefrom by 1·9 per cent. As the receipts from season tickets fell off by 4·9 per cent. and parcels traffic by 5·8 per cent. there was a decrease of 3·2 per cent. in the total receipts from passenger traffic. The tonnage of freight traffic fell by 5·0 per cent. and the freight receipts by 8·3 per cent. General merchandise accounted for 6·2 per cent. and 8·0 per cent. respectively of these figures. There was a decrease of 1·2 per cent. in the passenger train mileage and of 5·7 per cent. in the freight train mileage.

When steam heating was introduced on the South African Railways, the trains usually consisted of seven or eight coaches only. The leakage of steam from the couplings created a difficulty in maintaining efficient heating throughout the longer modern trains of fourteen or fifteen coaches. World-wide tenders were invited a few years ago by the Administration for the supply of intermediate coupler heads, and tests were made with a view to obtaining effective heating, not only in the leading coaches, but throughout the train to the last of twelve or more bogie coaches. As a result of these tests, an improved type of coupler head was decided upon, the diameter of the through steam pipes was increased, and a new steam cock of an improved type was provided. These measures bettered the steam heating of trains to a marked degree and many passengers have expressed their appreciation of the change, particularly when travelling in coaches farthest from the engine.

When a railway accident occurs at times when the weather is abnormal, it is usual for the lay Press to conjecture that the cold or the heat, as the case may be, was a contributing factor. Thus it was suggested that the unusual cold weather led to the Carlisle derailment of January 3rd, 1931, and now it has been supposed that the warmer weather of last week had something to do with the Great Bridgeford accident on Friday, the 17th. Whilst derailments due to heat distortion of the track are somewhat frequent in the United States, they are most uncommon in this country, and during the last thirty years there have been only five accidents reported upon in which that has been a factor. The five cases were:—March 26th, 1907, Felling; June 19th, 1912, Whitstable; May 16th, 1913, Castleford; July 5th, 1923, Culver Junction; and April 5th, 1926, Tanfield. Two passengers were killed at Felling and a platelayer was fatally injured by the derailed vehicles at Castleford.

## Notes and Memoranda.

In a report of the Chemical Research Laboratory of the Department of Scientific and Industrial Research, on the effects of the atmosphere on copper and bronze, it is stated that even in a seaside town, such as Ramsgate, it is smoke and not salt which principally affects the metal.

The Royal Institution has received from the Becker family a gift of a number of Faraday letters; from Mr. D. O. Wollaston, Dr. Wollaston's Camera Lucida; and from Professor J. C. M'Lennan the apparatus in which the liquid helium, used in the demonstration at his evening discourse on Friday, June 3rd, was transported from Holland.

There is, says Mr. T. H. Hogg, of the Hydro-Electric Power Commission of Ontario, a definite tendency toward automatic and remote control of generating stations. At one large plant in Ontario, with an installed capacity of 54,000 H.P., remote control equipment is being installed that will enable the plant to be operated almost entirely from an adjacent station located some 2 miles upstream.

Speaking at the fourteenth annual conference of the Association for Education in Industry and Commerce, on Tuesday last, Mr. H. A. Roberts, the Secretary of the Cambridge University Appointments Board, said that several big companies were consistently taking graduates into their offices. Only thirty-one Cambridge graduates were appointed to commercial or industrial positions in 1906. In 1929 there were 258, though the number had fallen since owing to trade depression.

Work on the establishment of national standard specifications for sieves for testing purposes has been taken in hand by a technical committee recently organised under the auspices of the American Standards Association. The National Bureau of Standards and the American Society for Testing Materials are jointly directing the technical work of the committee. The committee is co-operating with a committee of the International Standards Association, which has been active in Europe for some years in an effort to secure a greater degree of uniformity in the various national standards for testing sieves.

The following proportions are given by Mr. J. F. Hennessy as the extent and population of Australia:—The Continent has an area of 2,954,000 square miles, divided into eight States, New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, Northern Territory, and the Federal Territory of Canberra. The occupations of its people may be considered to be divided as follows:—Professional, 8·7 per cent.; domestic, 9·1 per cent.; commercial, 15·3 per cent.; transport and communication, 9 per cent.; industrial, 31·2 per cent.; primary production, 25·8 per cent.; independent, 0·9 per cent.

A precise levelling party sent out by the Geodetic Survey of Canada, Department of the Interior, in the course of a season's operations, not only establishes permanent bench marks every 2 miles, but, in addition, connects with provincial government, municipal, and corporation bench marks, prominent intersections, and points on railways and highways, water surfaces, gauges, and many natural features. Thus, a season's operations not only provide permanent marks of reference from which public and private engineers may commence spirit levelling for private and national engineering projects, but the secondary connections mentioned above serve as a connecting link to place all other levelling throughout the Dominion on the same datum, namely, mean sea level.

The first experimental units of the Pennsylvania Railroad's new electric freight locomotives which will go into operation upon the completion of the electrification of the railway between New York and Washington have been delivered. Except for the experimental steam locomotive built by the Timken Roller Bearing Company, these are, says the *Engineering News-Record*, the first locomotives to be built (presumably in America) with roller bearings. The new locomotives weigh 185 tons and are designed to haul longer trains at higher speeds than has been found economical with steam locomotives. Each unit has four pairs of 62in. driving wheels, each equipped with a motor. They are so designed that two or three units can be combined under the control of one engineman. All parts as far as possible are made interchangeable with the railway's new electric passenger locomotives.

In the course of a speech at the annual dinner of the Colliery Managers' Association, Sir Henry Walker, H.M. Chief Inspector of Mines, said it was important that the inert dust on the mine roads should be kept dry, so that it could rise with the coal dust. He believed this was the most important matter that had come out in connection with explosions since the stone-dusting regulations had come into force twelve years ago. The explosion at the Haig Pit, at the beginning of 1931, had spread a great deal further than it should have done if the inert dust had risen with the coal dust. It was proved afterwards that there was a tremendous amount of inert dust present, but that it was damp and did not rise with the coal dust. He appealed to colliery managers to ensure that the dust they were using would not cake, and that it would rise. That could be tested quite easily, and it should be done.

According to the twelfth annual report of the British Non-ferrous Metals Research Association, the work of the research, which is being carried out by Mr. E. J. Daniels, has been closely associated during the year with practical galvanising problems. Among these, the failure of the steel galvanising kettles, the formation of dross and the action of fluxes have received special consideration. Experimental work has determined some of the factors affecting the life of kettles, and has set on a scientific basis the reactions concerning the formation of dross and the function of fluxes. Considerable attention has also been paid to the corrosion of galvanised articles, and, as an extension of this aspect of the work, arrangements are being made for an investigation upon the corrosion of galvanised hot water tanks, and on the question of suitable tests for the quality of zinc coatings to be carried out at Cambridge under the supervision of Mr. U. R. Evans.

## Miscellanea.

The Blyth Harbour Commission celebrated its jubilee on June 18th.

The Capetown Municipality has decided to expend £500,000 on electricity works.

A hydro-electric supply scheme, to cost £14,000, is being started at Nelspruit, South Africa.

Work is about to be started on mining the extensive tungsten ore deposits of Lunenburg County, Nova Scotia.

A contract for £500,000 worth of steel has, it is announced, been settled between Russia and Poland. Poland is to buy furs and fish from Russia in exchange for the steel.

The new bridge which has been built across the Kanhan River, at Ramakona, in the Central Provinces of India, will be submerged by about 15ft. of water in times of high flood. It is of reinforced concrete and has five spans of 90ft. each.

When the Cunard liner "Scythia" arrived at New York on Monday night it was stated that no comment could be made on the use in her furnaces of colloidal fuel, referred to in last week's Journal Notes, before the round trip was completed.

The accident death-rate among employees in American bituminous coal mines during 1930 was 2·16 per million man-hours worked. There were 5890 mines at work and of these 4885 had no accidents. The total amount of coal raised was 467,526,299 tons.

In a line of precise levels run across the continent from mean sea level on the Atlantic to mean sea level on the Pacific, the engineers of the Geodetic Survey of Canada, Department of the Interior, obtained an apparent difference of elevation of only about 6in.

While the revenue has been steadily increasing each year, the cost of electricity in Cape Town has been steadily decreasing, as is shown by the fact that whereas in 1922 the average price received per unit sold was 3·371d., in 1931 this figure was reduced to 1·605d.

The Estimates of Expenditure on Capital and Betterment Works for the South African Railways and Harbours during the current year total £1,498,157, a reduction of £2,065,908 on the previous year. Besides this amount, however, it is proposed to spend £2,031,823 from the renewals fund and £31,651 from working votes and released material.

In view of the scarcity of water in some parts of Calcutta, specially in bustees, which generally compels people to use unfiltered water and insanitary tank water, the Waterworks Committee of the Corporation of Calcutta has given direction that the twelve lorries purchased last year for road-watering and other purposes be diverted to supplying filtered water in the city.

The Norwegian State Railways have contracted to take 90,000 tons of Svalbard (Spitsbergen) coal from the Store Norske Spitsbergen Kullkompagni. According to the *Norges Handels og Sjöfartstidende*, the basis price is 17·25 kr. per ton; last year's price was 17 kr. per ton. The contract provides for the price to be increased or decreased slightly if analyses of the coal supplied show that it has a higher or lower calorific value than fixed in the contract.

A world's record in shaft sinking is claimed by the West Rand Consolidated Mines, where in March the new South Shaft was sunk a distance of 400ft. at a cost of £24 13s. 8d. a foot. The April figures show that the March record has been exceeded by 2ft., the April total footage sunk being 389ft., an average of 13ft. per day. There was one working day less in April than in March. The sinking was commenced in January last, and the total depth reached is close on 1400ft. It is now anticipated that the ultimate depth of 4000ft. will be reached by the end of the present year, which would constitute another record.

The installation of the lighting equipment at the Capetown Airport has, says the *South African Mining and Engineering Journal*, been completed by the contractors. The illumination produced at the centre of the aerodrome by the eight 330,000 candle-power flood lamps, *i.e.*, where the intensity of the light is a minimum, was tested and found to be of the order of 0·3 foot-candles, which is understood to be more than twice the illumination produced at other aerodromes in South Africa where similar equipment is installed; this, moreover, is double the requirements of a Class "A" airport in other parts of the world, for which a minimum illumination of 0·15 foot-candles is specified.

The Canadian Pacific liner "Empress of Britain," the largest vessel built in the United Kingdom since the war, broke both her west-bound and east-bound records for the crossing to Canada in the course of the round trip which was completed at Southampton on Tuesday night. Her average speeds for the two journeys were 24·73 and 24·83 knots respectively. On her west-bound journey she travelled from Cherbourg breakwater to Father Point in 4 days 8 hours 52 minutes, compared with the previous record of 4 days 9 hours 15 minutes. She made her return journey from Father Point to Cherbourg in 4 days 7 hours 58 minutes, compared with 4 days 9 hours 17 minutes. Fog had delayed her during the west-bound trip.

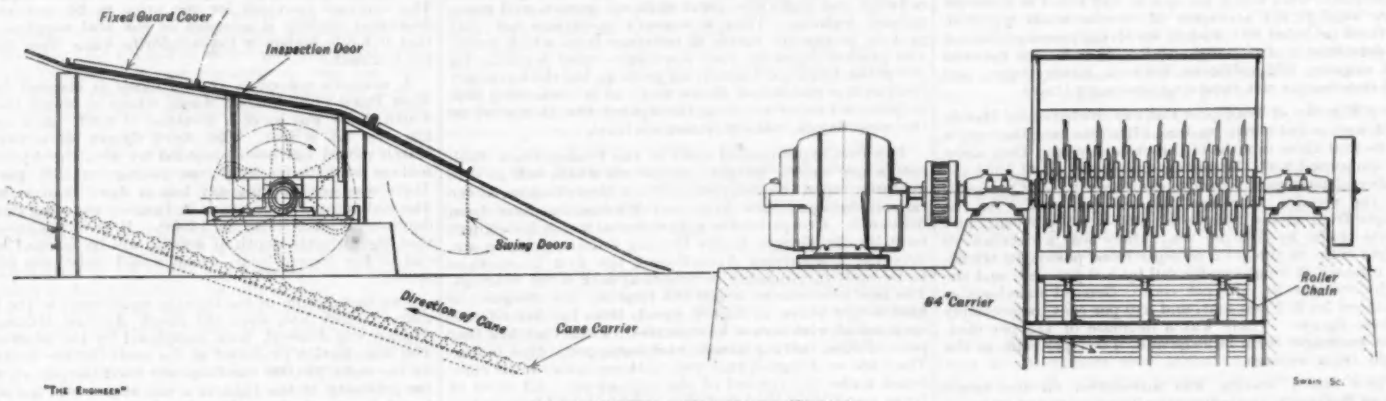
The Institute for Research in Agricultural Engineering recently imported a combined hay baler with power take-off drive, as recommended by Messrs. Baxter, Clarke and Newman in their report on "The Use of Agricultural Machinery in Canada and the United States of America." As considerable interest has been evinced by the agricultural community in this machine, it was thought that, although no public demonstration will be possible this year, an opportunity should be given for this machine to be seen at work during its trials. The machine was demonstrated on a crop of lucerne on Lord Lymington's farm at Farleigh Wallop, in Hampshire, on Tuesday last, June 21st, and the following days, and Lord Lymington kindly gave permission for all visitors introduced by this Institute to see the machine under working conditions.

# ELECTRICALLY-DRIVEN SUGAR CANE MILLING PLANT

THE MIRRLEES WATSON COMPANY, LTD., GLASGOW, ENGINEERS

(*For description see page 687.*)

VIEW OF COMPLETE PLANT IN MAKERS' SHOPS

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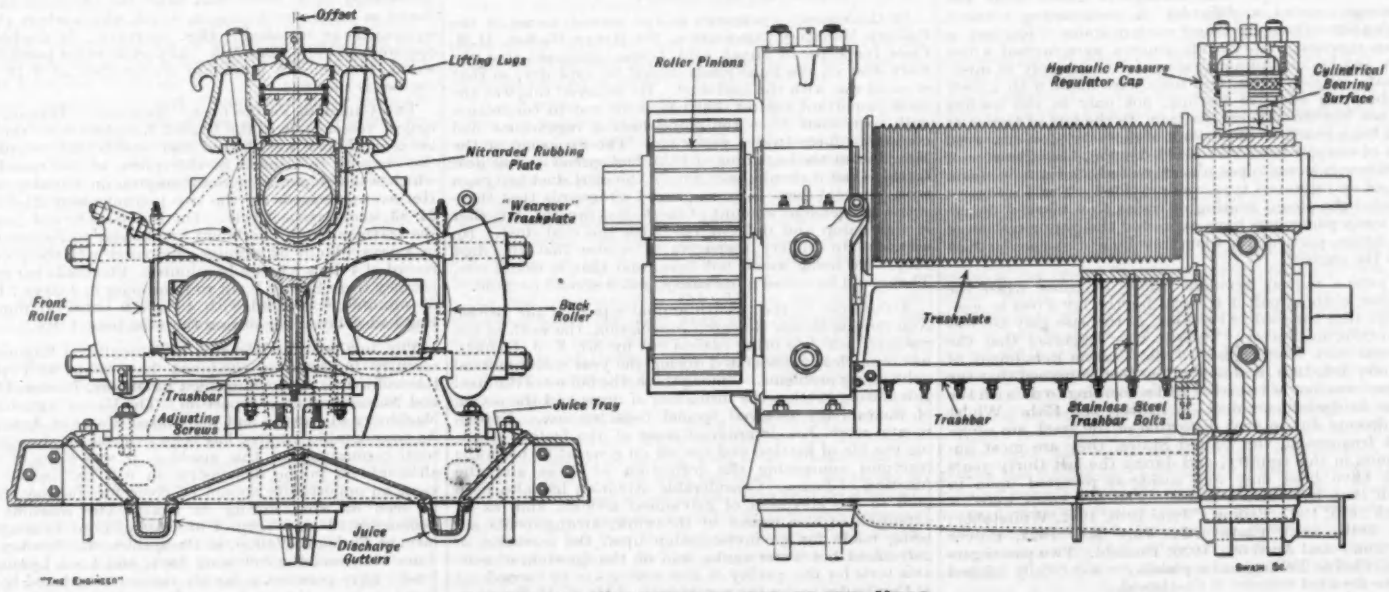


SECTION AND ELEVATION OF ONE OF THE MILLS

# The Engineer

*JUNE 24, 1932.*

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### The Metallurgist.

THE JUNE NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

## A NEW THEORY OF LUBRICATION.

AT the beginning of this month a new theory of lubrication was developed in a paper, "The Mechanism of Lubrication," which Mr. W. F. Parish and Mr. Leon Cammen presented before the Lubrication Engineering Committee of the American Society of Mechanical Engineers. Whether it is strictly correct to refer to the theory as a new one we have some doubt, but we are quite certain that the experimental methods and results on which it is based demand the careful attention of all interested in the vital and perplexing phenomena of lubrication. On page 699 we reproduce a drawing illustrating Messrs. Parish and Cammen's experimental equipment. A full description of the plant is not given in the original paper, but it is fairly obvious that it consists in essence of a vacuum chamber containing a high-speed hollow fly-wheel through which fluid may be circulated for the purpose of controlling the temperature conditions. The fly-wheel or rotor is 10in. in diameter and may be run at any speed from 1000 to 18,000 r.p.m. The apparatus was designed and constructed in co-operation with the Sperry Gyroscope Corporation, a company possessing exceptional experience in the production of extra high-speed, accurately balanced rotors. At the highest speed the rotor has a peripheral velocity of almost nine miles a minute. We might justifiably describe even half that speed as terrific in any machine. The warning of danger which the authors give in their paper is almost superfluous. The rotor may be made of steel, bronze, or other metal in order to vary the experimental conditions. Its surface is smeared or swabbed with the oil to be tested, and the phenomena which occur as the rotor is speeded up are observed. Under the action of centrifugal force the oil is thrown or torn off the rotor. The disruptive force acting on the oil film at any speed can readily be calculated and its direction is definitely radial. The apparatus therefore constitutes a mechanical device for measuring the adhesion existing within the oil, and between the oil and the metal of the rotor. So far only preliminary results have been obtained. While they confirm existing knowledge and theory concerning the formation and characteristics of oil films on metal surfaces, they carry the subject several steps farther and seem to provide the basis for a deeper understanding of lubrication phenomena.

It may, of course, be said at once that the apparatus in nowise reproduces the conditions under which oil exists in a lubricated bearing. In an uncapped bearing centrifugal force may be a factor affecting the retention of the oil, but it hardly enters at all into the factors affecting the establishment and maintenance of the oil film between the shaft and the "brass." According to modern opinion that oil film is composed of more than one layer. Adjacent to the shaft the oil is believed to be in chemical union with the metal of the shaft. A similar chemically united oil-metal layer is likewise believed to exist at the surface of the brass. Each of these layers, referred to by Messrs. Parish and Cammen as the Langmuir layers—we in this country might perhaps call them the Hardy layers—is believed to be only about one molecule thick. Between the Langmuir layers on the shaft and the brass there is a fluid film of lubricant which may be of any thickness from that corresponding to the conditions of "hydrodynamical" lubrication down to zero, in which case we get the conditions of "boundary" lubrication. Some authorities subdivide this fluid film into a central mass of freely moving fluid bounded by layers which are held against the Langmuir layers by an electrical or magnetic field existing at the boundaries of the shaft and brass. These layers, regarded commonly as being more or less rigidly attached to the shaft and brass, are referred to by Messrs. Parish and Cammen as the Coulomb Law layers. Much light can obviously be thrown upon the phenomena of lubrication if we can measure the force with which the various films adhere to the bearing surfaces. The Sperry-Cammen tester is designed to permit that measurement to be effected, and obviously does so in a very direct way. By a study of the manner in which the oil is thrown off the rotor as its speed is raised Messrs. Parish and Cammen have established, or claim to have established, the existence of the fluid film, the Coulomb Law layer, and the Langmuir layer. In addition, they have found that there is a fourth layer, which they designate the Parish layer, which lies below the Langmuir layer and which apparently is in the nature of oil adsorbed in the pores, cracks, and interstices of the metal immediately beneath its oil-metal boundary. It would appear that while some or all of the Coulomb Law layer may be removed by the centrifugal force, the Langmuir layer is very adhesive. It, and any portion of the Coulomb Law layer which may remain, can, however, be removed by means of a piece of bond paper held against the rotating periphery. After the rotor has been apparently completely dried in this manner a fresh layer of oil forms on the surface. The Coulomb Law and Langmuir layers are in fact re-established by the adsorbed oil of the Parish layer driven outwards by the centrifugal action. The outward flow ceases when the re-established layers exert sufficient pressure to retain the residue of the Parish layer in the pores of the metal. On the removal of the re-established layers the flow is again manifested. In one recorded case, that of lard oil on a steel rotor, as many as twenty-one layers were successively formed and removed before the action ceased. At first sight it might appear that Messrs. Parish and Cammen's investigation, while yielding interesting results, does not materially affect the theory of lubrication as now generally accepted. If, however, the views which they advance concerning the mechanism of lubrication can be confirmed, nothing short of the complete abandonment of the classical theory would appear to be indicated. According to them, the true seat of the lubricating action is not in the intermediate or fluid film, but in the Coulomb Law and Langmuir layers. The fluid film is loosely held and is easily squeezed out by the pressure of the shaft on the bearing. The Coulomb Law and Langmuir layers are, however, held very firmly to the surfaces by electrical and chemical forces, and it is upon them that the shaft primarily rides. Because of the excentricity of the shaft relatively to the bearing there is a dragging action which effects the same result as the removal of the Coulomb Law and Langmuir layers by means of the bond paper. These two layers are wiped off both the shaft and the brass, with the result that the pressure on the adsorbed oil is released. That oil flows out of the pores in the metal and not only re-establishes the Coulomb Law and Langmuir layers, but by its pressure lifts the shaft out of metallic contact with the brass. The action is practically instantaneous, and almost as soon as the two layers are re-formed by the outward flow of the adsorbed oil the shaft has turned to a fresh point of contact. The lightly held free film of oil takes no part in the actual lubrication of the bearing beyond acting as a storage reservoir for restoring the Coulomb Law, the Langmuir, and the Parish layers. Except in so far as the free film plays an important part in the escape of heat from the bearing and in absorbing shocks transmitted to it, the bulk of the substance of which the free film is composed need have no real lubricating property. All that is required of it is that it should carry a sufficient percentage of real lubricant to enable the three effective layers to be established and maintained.

Whether or not we accept the Parish-Cammen theory as completely and satisfactorily established, it must be admitted that it explains certain facts which have hitherto puzzled students of lubrication phenomena. Further, it confirms some opinions which various investigators have formed regarding certain aspects of the subject. Lord Rayleigh, for example, reached the conclusion that castor oil owes some of its characteristics as a lubricant to the fact that it is not homogeneous, but contains a major and a minor ingredient, of which the minor is the more important. Again, neither shale oil nor kerosene possesses any real lubricating property by itself. With, however, 10 to 20 per cent. of sperm oil or lard respectively they become good lubricants. Presumably the sperm or lard is present in sufficient amount to establish and maintain the effective lubricating layers, the shale oil and kerosene serving merely as carriers. Finally, the new theory sheds light on the puzzling fact that anything, such as free fatty acid, which lowers the surface tension of a lubricant, improves its lubricating properties. It would be thought that high surface tension was desirable in a lubricant, for the higher the surface tension the greater would be the resistance of the "lubricating film" to rupture. Actually the reverse is true, apparently, as may now be suggested, because the less the surface tension the more readily will the lubricant penetrate the pores of the metal and the more completely will the adsorbed Parish layer be established.

### Too Many Engineers?

IN a leading article our contemporary *Iron Age* comments upon what, at first sight, would appear to be no more than a natural result of the industrial depression in America. A few years ago it was the practice of American engineering firms to send representatives in the spring to the leading technical colleges to engage the most promising students at the conclusion of their education. There were then not enough embryonic engineers to satisfy the demand, and industry "had difficulty in filling its quota with the type of graduates it wanted." Last year the position was reversed; graduates became a drug upon the market. Instead of being sought, they had to seek, and few were successful in securing engagements. At a Central Western engineering school, it is reported that only one in fourteen of the outgoing class has been placed in industry, and the Dean of Princeton has written that "whereas in some years there were many more openings than graduates, this year only one outgoing Princeton man in thirty has a chance to go to work." As far as our evidence goes, the condition in the United Kingdom in this respect is by no means unsatisfactory, but we know that in France it is very difficult to place students, whilst in Germany the position is so bad that the Verein deutscher Ingenieure made a special appeal last year to engineers and shipbuilders to employ young men for the merest nominal pay. There are ordinarily 40,000 students in the German technical high schools and higher training colleges, and the annual output of graduates is 8000. The Verein reported that only 20 per cent. of these youths found engineering posts last year, another 20 per cent. took any work they could get—even as waiters—and 10 per cent. continued their studies. The remaining 50 per cent. were without occupation.

Grave as this position of affairs is, it appears, as we have suggested, to be ascribable to the prevailing depression, and one would hardly regard it

as a cause for censure of the colleges. It seems to be no more than a reflection of the bad condition of the engineering industry, and it may be expected to pass when the trade of the world revives. That, however, is not the view of our American contemporary. "There are," it writes, "many signs that in college education, as in industry, the machinery of production has been built up out of all proportion to the capacity of the market to consume the product." It goes on to say that college training "will be up for appraisal" with other prime factors in American life, and ends up by a riposte upon the colleges for their "many preachments concerning the shortcomings of modern business." "If we mistake not," it says, "the years just ahead will prove quite as trying to our colleges as to industry in the changes they will demand in methods and aims, and most of all in the *quantity and quality* of the product." The italics are ours. They leave no doubt that the *Iron Age*, which may be presumed to speak with intimate knowledge of the industry it represents, is not satisfied with the quality of the graduates, and holds that the output is in excess of requirements. It would be easy to dismiss this complaint with the remark that it has no bearing on this country, that American technical education is admitted, even by Americans, to be on a lower level than that of Europe, and that if there is an excess of graduates the simple course is to tighten up the curricula, so that a smaller number pass out annually. That, however, would fail to go to the bottom of the matter or to recognise the real significance of the position. The fact is that America, like Germany, France, and Great Britain, has built up an enormous and costly system of technical education, which must be maintained. It has great colleges, universities, and schools, with expensive equipment and large expert staffs. In spite of endowments and State grants, a large income from fees is essential to the life of these institutions, and in consequence the entrance of students is encouraged. Exactly the same condition prevails in this country. Even our municipal technical schools which are mainly supported out of the rates depend in some measure upon the fees raised, but, apart from that, they have to justify their existence, not only by the size of their classes, but by the successes achieved by their students. To keep their vast educational machines supplied with the necessary quota of students, propaganda is continually employed by all countries. The advantages of technical education to the student and to the nation are ceaselessly insisted upon and colleges vie with each other in the excellence of their accommodation and the costliness of their equipment in order to impress potential students or their parents. Great Britain is, if anything, behindhand in these respects. Other European nations have technical colleges which are the envy of our own educationalists, and have a larger number of students in proportion to the population. But even our relatively modest efforts may have to come up for the "appraisal" with which our contemporary threatens the American institutions.

Several years ago one or two British technical colleges printed, from time to time, a tabular statement showing the subsequent careers of their alumni. We have not seen any returns of that kind for some time, and we assume that the production of them has either been allowed to lapse or they are not made public. No doubt, trouble in keeping touch with past students was experienced, but in view of the value that such a record would be in an attempt to estimate the efficiency of technical teaching institutions, its revival and general adoption is worthy of consideration. Without some such census, an "appraisal" of the kind that the *Iron Age* appears to have in mind would be exceedingly difficult. Facts, and nothing less than facts, will show clearly whether the capacity of technical schools in any country is greater or less than the national needs, and enable a good guess, to say the least, to be made at the suitability of the education given and the standard attained. If, for example, it were found that whilst all the graduates were absorbed fairly rapidly into technical industries, and yet that a large proportion of them failed to make due progress in their vocation, it would be reasonable to conclude that a revision of curricula was desirable. Many attempts, both here and abroad, have been made by means of questionnaires to discover the attitude of employers towards technical graduates, but they have been far from complete, and reflect too much personal feeling to be wholly satisfactory in other respects. To reach safe—or fairly safe—conclusions, the career of all students from technical schools of all grades should be recorded periodically. Then we should have something definite to work upon. At present we can only grope rather blindly, and have but little precise knowledge of the real efficiency of the great educational machine.

## Incorporated Municipal Electrical Association.

FOR the first time since the war years the Annual Convention of the Incorporated Municipal Electrical Association was this year reduced to a matter of two days instead of the usual week. The President this year is Mr. C. G. Morley New (the chief electrical engineer to the Cardiff Corporation), and the Conference was held in that city on June 16th and 17th.

The attendance at the Convention was necessarily smaller than in some recent years when, indeed, it began to mount to almost inconvenient proportions, and it became necessary to limit the number of representatives of manufacturers and others who were not actually members of the Association. This year the attendance fell from a figure of about 1200 last year to 750, but on the whole it must be said that the Conference was a success from the business point of view, and, of course, it goes without saying that on the social side there was nothing to complain of. One of the consequences of the present financial position is that Local Authorities do not find themselves justified in extending to such Conferences any hospitality which would involve expenditure which falls upon the rates, and so at Cardiff anything in the nature of official luncheons, &c., which usually form a feature of the programmes, was absent.

### PRESIDENTIAL ADDRESS.

On Thursday, June 16th, in the City Hall, however, the Lord Mayor of Cardiff (Alderman C. W. Melhuish, J.P.), gave a civic welcome to the Association, after which Mr. C. J. Morley New delivered his Presidential Address. In it he referred to a number of matters affecting the industry, and commented upon the position of supply undertakers under the "Grid" scheme. There are now nearly 400 local authority electricity supply undertakings in the country upon which more than £200,000,000 has been spent, and it was claimed that an extension of the capital expenditure upon such undertakings from £4,000,000 in 1896 to £200,000,000 in 1930 indicates that local authorities as a whole have realised the moral obligations placed upon them in making generally available to the public they serve the commodity which they hold statutory rights to supply.

Taking the three large items of cost in electricity supply, namely, capital, labour, and fuel, Mr. Morley New analysed the progress that has been made in effecting economies in production. In 1921–22 the units sold to consumers per £100 of capital expenditure were 2189; in 1924–25 the figure had risen to 2624; but in 1929–30, owing to industrial depression, the figure remained practically stationary at 2649 for local authority and company supplies, the local authority figure being 2715 in 1930. There is no question, however, that a great improvement in this respect will be shown with more normal activity of industry, as in recent years a large expenditure has been incurred on distribution which is not yet fully remunerative. Another figure of some interest which was given relates to the sales per employee. The number of men engaged in all sections of local authority supply undertakings increased from 3359 in 1922–23 to 61,620 in 1929–30, but the sales to consumers per man employed increased from 103,471 units to 140,636 units between those two periods. Generation alone in the same period showed an increase from 230,380 units to 462,360 units per man employed, or an increase of 100·7 per cent. It is, however, in fuel consumption that spectacular savings have been effected. Between the years 1920–21 and 1929–30 there has been a saving of 1·43 lb. per unit generated, equivalent to 6,436,277 tons of coal on the consumption for 1929–30, which at 15s. per ton gives a saving of £4,822,207. Thus, it can be said that the fuel charges on a large proportion of recent plant extensions are being made out of savings in fuel. At the same time, during the period mentioned, the average revenue received per unit from consumers of local authority supply undertakings was reduced by no less than 48 per cent.

All this, contended Mr. Morley New, represents rationalisation of a type which has much to commend it, but, he added, he would hesitate before introducing any further schemes for better conduct of the industry if they entailed substitution of personal control by that impersonal control associated with some huge undertakings.

Dealing with the co-ordination of generation, it was pointed out that although until recent years local authorities have been responsible for fully two-thirds of the total quantity of electricity generated and distributed to consumers, if the national scheme is carried out on the lines now being developed, the position will ultimately be that generation will be about equally divided between company and local authority undertakings as to output, whilst on balance the company stations will operate at higher load factors and local authorities will be importing supplies. This, it was suggested, might not be very comforting to local authorities, but the important point was emphasised that electricity must be obtained at the lowest possible cost, no matter what the source, and the main duty of local authorities was to supply consumers at the lowest possible price.

As to the cost of the standardisation of frequency, it was pointed out that in a few years this will reach nearly £900,000 per annum, or about four times the amount now being levied for this purpose, and, with the cost of the "Grid," will constitute an addition to the fixed charges on the industry of about £4,000,000 per annum. Therefore every effort must be made to increase revenue by increasing demand.

Discussing the question of price for bulk supply, it was urged that the cost of electricity supplies under the Government scheme, as between one site and another, must not be such as to prove a deterrent to the establishment of industries in the neighbourhood of small towns, and that given these conditions, medium and small-size undertakings should be in a much better position than they are to-day to negotiate for really large loads. In this connection, the wholehearted co-operation of the Central Electricity Board was pleaded for in order that the bulk supply tariff of the latter might be reconciled with one acceptable to the large power users in all towns. Power consumers, it was pointed out, are chiefly concerned with the average price per unit, and do not like a tariff in which the fixed charge is accentuated. In any case they expect some safeguard as to the maximum price per unit, so that they may be covered against what by them is considered an unduly high price, should their operations have to be curtailed, otherwise the inference is that large consumers will prefer to install their own plants.

It was inevitable perhaps that reference should be made to the possibility of Government action in regard to distribution on similar lines to that which has already been taken in the matter of generation. Indeed, not only the Minister of Transport in the late Labour Government, but also the present Minister of Transport has thrown out a hint of this kind, and therefore once again supply authorities were urged by Mr. Morley New to take action themselves in order to prevent this further incursion of Government activity into the industry. It was emphasised that the co-ordination of generation under the 1926 Act did not come from any desire on the part of the industry, but was the result of the failure of the 1919 Act to bring about the results that were expected. Mr. New urged that there is no necessity for setting up distributing authorities with large areas, because, provided the benefit of economical generation at certain stations is passed on to others, then electricity should be cheaper on the average throughout the whole country, and business should improve. The drawback at the moment is recognised to be a relatively few backward undertakings—both company and local authority—which do not appear yet to have recognised to the full their responsibility to the public. Moreover, it was pointed out that local authorities are often restricted in extending distribution beyond their boundaries, although this can be done in many cases to great advantage and without detriment to anybody, and, generally, Mr. Morley New put forward the view that provided a progressive outlook is developed and that legislative restrictions, where they exist, are removed, the work of the distribution of electricity throughout the country can proceed more effectively and with greater freedom without any attempt on the part of the Government to take a hand in the matter.

### SMALL ELECTRICITY UNDERTAKINGS.

The first paper presented to the Conference dealt with "The Organisation and Development of Small Electricity Undertakings," the author being F. Newey, chief electrical engineer at Long Eaton. For the purpose of the paper, the author took the case of an undertaking with less than 5000 consumers, although that was admitted to be an arbitrary definition, because it took no account of demand. I.M.E.A. definition of a "small undertaking" is one having an output of 10,000,000 units. Such an undertaking would obtain its supply in bulk, and the paper deals in great detail with the organisation necessary to develop the supply of electricity, the hiring of apparatus and the general internal details. The care needed in framing the financial policy of the Committee of such a small undertaking was emphasised, it being pointed out that the expenditure on apparatus, assisted wiring, and meters is often, at the present time, more than can be met out of revenue. The view was also urged that the profits of such an undertaking should be kept as low as possible, and the benefit be given to the consumers rather than using profits for relief of rates, it being pointed out how, by taking advantage of the present income tax as a "set-off" against tax deductions in the general accounts of a Council, it was possible for an electricity department to pay more than the statutory 1½ per cent. to the relief of rates, thus benefiting non-consumers, and even competitors, at the expense of the undertaking.

In the discussion a number of engineers of small stations gave details of the development of their undertakings by the adoption of a progressive policy

on the distribution and service side. Some matters of general interest, however, were also mentioned. For instance, Mr. M. S. Mason (chief engineer at Worksop) urged the lamp manufacturers to reduce the price of lamps—a request that is made at almost every I.M.E.A. Conference—and complained of the manner in which progress in the smaller towns is being retarded by the restriction placed by the B.E.A.M.A. Council upon their members exhibiting at local exhibitions. In the same way he suggested that the Electrical Development Association should assist local propaganda more rather than confine itself almost exclusively to national propaganda.

Mr. W. A. Walker (chief engineer, Kettering) suggested that Mr. W. R. Rawlings (President, Electrical Contractors' Association), who was present, might have something to say on the part that could be played by electrical contractors in assisting development in small districts. Mr. Rawlings, however, did not respond to the invitation, despite Mr. Walker's subsequent contention that some contractors often failed to fulfil their obligations to the public in that respect. At the same time, he spoke in terms of praise of the registered contractors' scheme, and of the manner in which an increasing number of municipal electrical undertakings are now making use only of the services of registered contractors.

Mr. F. Price White (chief engineer, Bangor) caused some amusement by emphatically predicting that the gas industry will in a very short time go out of existence altogether, but perhaps he was on more solid ground in some of his other suggestions; for instance, that the Electricity Commissioners should recognise that the life of mains is considerably longer than the period now allowed for the repayment of loans, and also that a longer period than five to seven years should be allowed for the repayment of the capital involved in a change over from D.C. to A.C.

Alderman R. S. Chatfield (Chairman, Eastbourne Electricity Committee) suggested that the I.M.E.A. Council might try to evolve a standard policy of development for undertakings of the character dealt with in the paper, claiming that much of the work now being done by way of propaganda by the Electrical Development Association and by way of research by the Electrical Research Association was being wasted through the lack of some standardisation of a development policy.

There was no time for the author to reply to the discussion in detail.

### PUBLIC ELECTRIC LIGHTING.

In the afternoon of Thursday, June 16th, a provocative paper on "Public Lighting by Electricity" was presented by Mr. J. N. Waite (City Electrical Engineer, Hull) and Mr. W. J. Jones (Manager, E.L.M.A. Lighting Service Bureau). In putting the case for street electric lighting based on experience gained by a number of active municipal electrical engineers in different parts of the country, the authors attacked the position of the gas industry in regard to street lighting from a somewhat new angle, and in doing so paid little attention to the views held by some people that in dealing with electricity *versus* gas competition in any form electrical engineers should confine themselves only to stating the advantages of electricity without pointing out what to them are regarded as defects in competitive supplies. On the contrary, this paper made great use of independent tests on gas lamps which have been carried out at the National Physical Laboratory and which the authors asserted demolished many of the claims put forward by the gas industry in regard to street lighting. For instance, it has long been claimed by the gas industry that a gas mantle maintains its efficiency practically unchanged throughout its life, whereas the electric lamp gradually loses efficiency from the very start. Figures were given from the N.P.L. tests indicating that unless a very high degree of maintenance of gas mantles and fittings is practiced there can be a depreciation of efficiency, under London conditions at any rate, of anything from 8½ to 63 per cent. It is admitted that probably the highest standard of maintenance of public gas lighting is to be found in Central London, but even there the figures given indicate a great variation in the illumination obtained night after night.

In connection with this attack upon gas lighting the authors also dealt with the candle-power ratings of gas and electric lamps, pointing out that the gas industry has not yet adopted any standard method of rating candle-power values of street lighting lanterns. At times the candle-power values given refer to the average candle-power realised in the lower hemisphere; at other times the candle-power values between 10 deg. and 20 deg. below the horizontal are given, whilst since the introduction of clusters of mantles there has been a tendency to give a candle-power rating equivalent to the maximum candle-power obtained in any position below the horizontal. None of these ratings, however, it was contended, are any use whatsoever in arriving at the total light emitted, and that as a means of comparison of total light emission the only true rating is that known as the mean spherical candle-power, *i.e.*, the average candle-power given in every direction from the light source. This is the basis of candle-power ratings for electric lamps.

Dealing with the electrical side of the problem, the paper suggested that at present-day inadequate intensities the street lighting load would consume approximately 300 million units per annum, but in presenting the paper the authors added that that figure might easily be doubled if the intensities of illumination were of the order demanded by modern conditions. Speaking of the progress made by street electric lighting—to dispose of the impression which is sometimes given that street electric lighting is only to be found in a few back streets—it was pointed out that from 1922 to 1930 the units consumed for public lighting in this country increased from 49·5 million units to 144 million units, despite the fact that during that period there had been a reduction in the average price charged for electricity for street lighting purposes of 45 per cent. From experience in Hull and similar places it was suggested that public lighting for all-night purposes could be given remuneratively at ¼d. per unit, and figures were presented of many examples of street electric lighting in which the total cost was lower and the total amount of light provided very much higher than that previously given by gas.

The paper contains a vast amount of information obtained from actual practice of what is possible under varying conditions with public lighting by electricity and is a distinct departure from many previous papers on the subject in that the authors put their case forward in an uncompromising manner.

There was naturally a long discussion on the paper, in which, whilst the general principles enunciated by the authors were not challenged, there were, however, differences of opinion on matters of detail. For instance, the figure of ¼d. per unit was disputed by several speakers as being too low in many instances, but on the whole the discussion was an amplification of the views put forward by the authors.

Mr. P. J. Robinson (Chief Electrical Engineer, Liverpool) criticised the Thames Embankment electric lighting and suggested that the only high standard about it was to be found in the standards used for the lamps. He preferred the use of diagonal span wires, as used in Liverpool for some years. In Liverpool the mileage of electrically lighted streets had increased, he said, from 18·25 to 216·87 during the past ten years, whilst the mileage of gas lighted streets had been reduced from 707 to 601. Incidentally, Mr. Robinson is also the City Lighting Engineer and does not find it easy to reconcile that position, in which he desires to purchase current at the lowest possible price, with the position of City Electrical Engineer, in which he naturally desires to obtain as high a price as possible. It follows that with the large increase in the mileage of streets electrically lighted in Liverpool there has been a large increase in the number of units consumed, the figures being 589,774 ten years ago and 4,345,465 units last year.

Alderman W. Walker (Manchester) spoke of a similarly large increase in street lighting in Manchester, and inquired of the representatives of E.L.M.A. when the new illuminous tubes now being experimented with having a wave length approximating to that of daylight, which, he said, would mean 100 per cent. efficiency, would be available.

Mr. E. J. Jennings (Birmingham) was another uncompromising antagonist of gas and referred to an experimental test of gas and electricity in certain streets in Birmingham, concerning which two independent experts reported that whilst in foot-candles the gas lamps gave 20 per cent. better light underneath the lamps, at the mean distances between the lamps the electric lighting installation gave an 80 per cent. better result.

Mr. W. N. C. Clinch (Chief Electrical Engineer, Brighton) drew the attention of street electric lighting fittings manufacturers to the need for improvements which will render the cost of maintenance less than at present.

Alderman J. W. Longley (Chairman, Bradford Electricity Committee) commented on the fact that whereas ten years is the period allowed for the repayment of loans for street lighting standards, twenty or twenty-five years is allowed for practically similar standards used for tramway purposes.

Mr. C. W. Sully (E.L.M.A.) said it was impossible at the moment to say when the new luminous tubes which had been mentioned would be available, the aim being to ensure that they would give complete satisfaction when placed on the market. Speaking of the agreement between the I.M.E.A. and E.L.M.A. as to a 1000 hours' guarantee for the life of lamps used for street lighting, he said not much use had been made of that, as the life was longer than 1000 hours on the average, but the makers were hard at work in an endeavour to remove the large variation in the life of such lamps, and he held out the hope of an amended life guarantee and also indicated that the lamp manufacturers will shortly be discussing the whole position with the municipalities and other public lighting authorities from a new angle.

After references had been made to the 100 per cent. street electric lighting installations at Watford and Maidstone, the authors briefly replied and again stoutly maintained the antagonistic attitude which had been adopted in the paper, claiming that the arguments were based on the results of practical experience and independent tests.

The annual dinner was held in the City Hall on Thursday, June 16th, and the principal guest was Mr. P. J. Pybus (Minister of Transport), who, in proposing "The Incorporated Municipal Electrical Association," spoke of the manner in which the electricity supply industry is progressing in this country as compared with Germany and America, and gave the as yet unpublished figures of the position relating to 1931. During that year the units sold amounted to 9,219,551,000, representing an increase of 329,190,000 units over the preceding year, the total percentage increase being 3·7 per cent., the local authorities showing a slightly better increase than the companies. Later Mr. Pybus gave a little advice to the Chairmen of the Municipal Electricity Committees and urged them, particularly at this time, when copper is so cheap, to adopt a bold policy of development, although at the same time dissociating himself from any suggestion that a reckless policy should be adopted.

Sir Andrew Duncan (Chairman, Central Electricity Board), who responded to the toast of "Our Guests and Ladies," said it was probable that the grid would be complete in a year's time, and he appealed for the most complete co-operation between supply authorities and the Board in order that the grid scheme might be made a success. To further this object he said that within the next few weeks it was the intention of the Central Electricity Board to set up a committee of engineers of selected stations and to co-opt on that committee representatives of the non-selected stations. Further, it was intended to set up a Central Committee consisting of representatives of the engineering side of the industry—both municipal and company—to assist the same object.

At the annual general meeting, which was held on Friday morning, June 17th, Mr. G. Porter (Chief Electrical Engineer, Worthing) was elected President for the coming year, with Mr. P. J. Robinson (Chief Electrical Engineer, Liverpool) as Vice-President.

On Friday afternoon, June 17th, a visit was paid to the works of the Whitehead Iron and Steel Company, Ltd., at Newport, Mon. The latest mill at the works is the 12in.–14in, semi-continuous bar mill, which was installed in 1931. The furnace is of the sloping type and has a hearth 36ft. in depth and 32ft. in width. It combines a number of special features, the most interesting of which are that the entire hearth is covered by an absolutely flat roof, which has so far proved very free from trouble and is efficient, whilst there is a special method of damper regulation which controls any part of the hearth. This mill, except for the diameter of the rolls and the breaking up of the drives between independent motors, follows very closely the design of the Tredegar semi-continuous bar mill which was installed in 1907. The Tredegar mill has been a remarkable success and has gained a great reputation for high finish, which the new mill is more than able to maintain. When trade conditions warrant, the Tredegar mill is to be removed to the Newport site, and the opportunity will then be taken to introduce certain improvements which will bring the unit completely up to date. The mill will also be probably arranged with an extension of the continuous roughing train for the purpose of producing wire rods on the straight continuous system. The new No. 3 mill is electrically operated throughout and the whole plant has been in continuous operation since May last, no hitch or trouble of any kind having been experienced. A large variety of sections has been rolled, including 2in. rounds, which have been looped through the mill quite satisfactorily.

## "THE METALLURGIST."

IN the June issue of THE METALLURGIST the leading articles deal with Alloys and British Steel. The first discusses the problem of arriving at the power of predicting the properties of alloys from a knowledge of their atomic constitution, and while pointing out that this is as yet impossible, indications are given that some progress towards a fundamental theory of alloys has already been made. Under the heading "British Steel," the work of the Committee recently appointed to reorganise the British steel industry is discussed, and attention is called to the importance of the technical and scientific aspects of the question which, it would seem, did not receive attention when the *personnel* of the Committee was selected. Other articles deal with Iron-Boron Alloys, Protective Metal Coatings, the Welding of Locomotive Fire-boxes, Short Time Creep Tests on Steel, Metals at High Temperatures, and Ingot Moulds. Books dealing with Chromium Plating and Metallurgy are reviewed.

## BOOKS RECEIVED.

*How to Drive a Car.* Twelfth edition. London: Temple Press, Ltd., 5–15, Rosebery-avenue, E.C. 1. Price 2s. 6d. net.

*Osiris and the Atom.* By J. G. Crowther. London: George Routledge and Sons, Ltd., 68–74, Carter-lane, E.C. 4. Price 5s. net.

*Directory of Paper Makers of Great Britain and Ireland,* 1932. London: Marchant, Singer and Co., 15, Nicholas-lane, E.C. 4. Price 5s. 6d. net.

*Buyers' Guide to the Motor Trade of Great Britain.* London: Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1.

*Ausgewählte Schweisskonstruktionen.* Volume 3: *Rohrleitungs- und Behälterbau.* Compiled by Dr.-Ing. Holler and Reg.-Baumeister a. D. Fink. Berlin: V.D.I. Verlag G.m.b.H., Dorotheenstrasse 40, N.W. 7. Price 12·50 marks.

# Institute of British Foundrymen.

No. II.*

## ANNUAL CONFERENCE AT NEWCASTLE.

In our last issue we gave some account of the opening proceedings of the Annual Conference of the Institute of British Foundrymen, and printed an abstract of the Presidential Address. To-day we deal with some of the papers.

### Moulding and Casting.

The first paper presented to the Conference was a French Exchange paper. Its title was "Introduction to the Study of Moulding and Casting," and it contains extracts from lectures delivered at the Foundry High School, Paris, by its author, Monsieur J. Pillon. The whole paper is profusely illustrated, containing no less than 135 blocks, and shows the type of education afforded at the Paris Foundry High School.

### Quantity Production of Grey Iron Castings.

A practical paper was presented by Mr. J. O'Sullivan, of Henry Ford and Sons' foundry at Cork. In this the author gives an account of the sequence of operations at his foundry, rather than a detailed account of the operations themselves.

After having passed inspection by the laboratory, the incoming bulk raw materials, embracing pig iron, coke, scrap, sands, and clays are loaded into storage bins; whilst the less bulky commodities, such as core wire, blacking, soluble starch, binders, oil, and other incidental foundry materials, are put into stores, from which they are withdrawn only against a signed requisition.

A night gang starts work at ten o'clock to prepare the cupolas for the next day. This gang removes the dump, chips and patches the cuploas, and has everything ready for the charging gang, a portion of which starts work one hour before the moulders arrive. Charging is all done by hand, in the sequence coke, limestone, steel, pig iron, borings, scrap, and ferro-silicon. There are seven cupolas—three of 60in., three of 56in., and one of 42in. internal diameter and of standard make. They are all fitted with both volume recording and pressure gauges. Once the blast is put on to the furnace it is run to a determined capacity, and the board on the charging floor should show a regular number of charges hourly. This is considered essential if the metal is to be kept within specification and machine shop expectations are to be fulfilled. Charge sheets are displayed on a blackboard. Silicon determinations of the metal are made hourly, and complete analyses of all metals are made at least once daily. The temperature of pouring is controlled by the laboratory. Invariably the first tap of iron is pigged, together with any surplus, into a pig-casting machine conveyor, which returns it to the charging floor. The liquid metal is conveyed by mono-rail from the cupola spout to the pouring stations.

The care of all core washes is undertaken by one man, who mixes and maintains the stocks. There are fourteen different mixtures of core sand, and three washes, and core mixtures are fed by means of chutes to the core-makers' tables on the floor below the mixing floor. All core-boxes are of metal and accurately machined, as are also the core plates and shell carriers. Wires are used very sparingly. Some men complete the boxes themselves, but other cores are made by a gang working around a circular table, the making of a core being split into several operations. The last operator places each completed core on a conveyor, running to the core ovens. All cores are checked, and production is marked up hourly. Core plates and shell driers, when stripped of cores, are returned to the core makers by conveyor. The core ovens are of the continuous type, heated by gas and controlled by recording pyrometers.

The moulding department consists of a jobbing shop where patterns and the general equipment used in the plant are made, and three conveyor systems—two of the drag and one of the reel type. One of the drag conveyors, on which large tractor castings are made, is equipped with power-jolt roll-over machines, and its capacity is upwards of 2800 moulds in eight hours. A description is given in the paper of the building up of the moulds on the conveyor on the way to the pouring station, and the travel of the moulds after pouring to the shake-out, where a chain conveyor conveys the castings to the cleaning department.

The importance of exact synchronisation with conveyor systems is manifest. If the metal arrives at the pouring stations too early it becomes cold and useless, and if it is late the conveyor has to wait, so that production is impeded.

### Ferrous and Non-ferrous Metals in the Foundry.

This was the title of a paper presented by Dr. W. Rosenhain, F.R.S., whose purpose was to emphasise that, although there are wide and important differences between ferrous and non-ferrous founding, and whilst he does not underrate those differences or their importance, there are far more points of similarity, and the workers in each field can learn a great deal from each other, and improve the standing of their own work by knowing something of the problems to be faced by the other man and the methods adopted to overcome them. Probably, he said, the most important difference between cast iron and the non-ferrous metals is the relatively low price of the former. In non-ferrous industries, metal losses are of serious importance, and the methods of melting particularly are designed to minimise such losses. In the case of cast iron, however, the cost of melting becomes a much more serious item in relation to the cost of the finished casting. The consequence has been that in the majority of cases the cheapest and simplest type of melting furnace has been employed for cast iron, with comparatively little regard for metal losses, and, he feared, in some instances, with no very great regard for the quality of the resulting product. If, he said, one compared the published literature of the two branches, one could not but be impressed by the fact that a great amount of duplication could be saved if those engaged in both branches could be induced to work closely together. Although the Institute of British Foundrymen covered both branches, there was the separation between the Institute of Metals and the Iron and Steel Institute, and the separate organisations of the British Cast Iron Research Association and the Non-ferrous Metals Research Association. He did not suggest that these various organisations should be amalgamated immediately, but there was undoubtedly a large amount of common ground upon which duplication of effort could and should be avoided. He hoped that this brief review of this aspect of the subject might do something to help developments in that direction.

* No. I. appeared June 17th.

### Hardening Cast Iron.

Mr. J. E. Hurst (last year's Oliver Stubbs Gold Medallist) contributed a paper describing experimental and development work carried out in the works and laboratories of the Sheepbridge Stokes Centrifugal Castings Company, Ltd., on hardened and tempered cast iron and nitrogen-hardened cast iron. Experiment has shown that cast iron of suitable composition, heat-treated in a suitable manner, can be hardened and its strength properties improved. It is this knowledge which must be considered to constitute the new discovery in relation to the hardening of cast iron by heat treatment. Experimental work demonstrating this fact has been published in papers read before the Sheffield Branch of the Institute in 1930 and 1931, dealing with oil-hardening and air-hardening cast iron. The present paper deals with experiments on a variety of further compositions. The important discovery arising out of all these experiments is that the hardening effect brought about by the rapid cooling from temperatures above the upper critical point in all the materials examined was accompanied by a deterioration of the strength properties. This deterioration of the strength properties was immediately restored by tempering, and for each of the materials examined there existed a tempering temperature at which the strength properties were restored to a value exceeding those of the original material in the as-cast condition. Thus, by suitable hardening and tempering, a definite improvement in the strength properties could be obtained. Details of the results obtained are given in the paper.

The author also deals with the nitrogen hardening of cast iron, which is essentially a case-hardening process in which the articles acquire exceptionally hard surfaces by maintaining them in contact with anhydrous ammonia gas at a temperature of approximately 500 deg. Cent. Cast iron suitable for nitrogen hardening is a special alloy cast iron, and the best results have been obtained so far with a cast iron alloyed with aluminium and chromium. During the nitrogen-hardening operation, nitrogen is liberated by the dissociation of the ammonia, and this is absorbed by the alloy cast iron. The articles are allowed to cool in contact with the ammonia, and are withdrawn when cool. No further treatment is necessary beyond the final lapping of polishing operation. The furnaces used are of the electrical resistance type, with automatic regulation.

A large number of cylinder liners of nitrogen-hardened cast iron have been manufactured and fitted to various types of engines, including petrol engines for heavy vehicles and pleasure cars, high-speed Diesel engines, and compression-ignition engines. In all cases excellent results are being obtained, and the figures now available for liners operating in engines on road transport are in all cases upwards of 20,000 actual miles per 0·001in. maximum cylinder wear.

### Contraction, Distortion, and Camber in Grey Iron Castings.

A paper of great interest to the practical moulder was contributed by Mr. E. Longden. He points to the striking lack of data and standards for camber allowances in castings, which need such treatment and says that this was to be expected. For long he sought information which could be more or less readily applied, but after exhaustive search over many years has come to the conclusion that reliable and easily applied rules and standards for camber to overcome deformation do not exist. Such information as is available is very contradictory and dangerous. With small and light castings of a repetition nature, the necessary bends, contours, or camber could be ascertained by trial and error without serious loss, but with large castings such methods would be fatal. His paper is the result of his efforts to provide the starting point for a workable basis for camber standards in medium and large castings of bed-plate design, but he does not claim that those advanced are perfect, as the design may introduce variables which would modify them. The paper contains some interesting examples of camber in large castings, and a camber chart for application to the heavier type of castings. The influence of metal temperature, composition of mould material, design, methods of moulding, &c., are discussed. It is pointed out also that any considerations for camber allowances must take into account not only ordinary contraction, as commonly understood, but also the phenomena of post-solidification expansion peculiar to cast iron.

### High-Test Cast Iron in the United States of America.

The American exchange paper was contributed by Mr. R. A. MacPherran, of the Allis-Chalmers Manufacturing Company, Milwaukee, and deals with the present status of high-test cast iron in America, this purpose being fulfilled by giving a few specific and typical cases in which this iron is being successfully used. The author points out that there is no standard quality for high-test iron and no specifications covering recent developments. Various foundries adopt the material and practice best suited to their own needs.

In the last few years, he says, there has been a marked tendency towards specialisation. One foundry specialises in automobile heads and cylinders, a second in pistons or rings, a third in brake drums, and so on. This specialisation has been assisted by the great production demand of the automobile industry and by the development of the electric furnace. Of the latter, it is estimated that over eighty have been installed in America for the production of commercial iron castings.

For the purpose of the paper the author includes as high-test cast irons only those breaking at more than 20 tons tensile per square inch. In general, high-test iron is made either by (*a*) electric furnace, with or without duplexing from cupola; (*b*) air furnace, with or without duplexing from cupola; and (*c*) cupola.

It is estimated that about 130 American foundries make an intermediate iron from charges containing about 50 or 60 per cent. of steel, with a tensile strength of 16·9 to 22·3 tons per square inch; and that about thirty foundries use a mixture for high-test iron with over 80 per cent. steel, with test bars breaking at over 22·3 tons per square inch.

The author expresses the view that the development of cast iron is only in its infancy, and that heat treatment and alloys will do as much for cast iron as they have done for cast steel.

### The Work of the Malleable Iron Sub-Committee.

The final paper presented at the Conference gives a *résumé* of the work of the Malleable Iron Sub-committee of the Institute's Technical Committee, from its inception on October 18th, 1930, to May, 1932.

Available specifications were examined, and it was found that the majority appeared to be based on the B.E.S.A. (B.S.I.) Specifications Nos. 309 and 310 of 1927. As the Institute was represented on the Committee compiling those specifications, it was decided that the examination of these two specifications should form the basis of the Sub-committee's work. The specifications deal particularly with mechanical tests upon a standardised size of test bar, and allow of a wide range of chemical composition, and this latitude in composition was approved by the Sub-committee.

Discussion had shown the specifications to be unsatisfactory in the following matters:—

(1) The standard set is low, easily attained, and often exceeded by the manufacturer. It seemed therefore that this standard should be re-examined and possibly raised.

(2) A standard-sized test bar is called for, but cannot always represent various sizes of castings. It is pointed out that in the manufacture of white-heart malleable castings of different thicknesses must be annealed under different conditions, and therefore test bars of a standard thickness, annealed with these different-sized castings, cannot give a true indication of the annealing of the batch they represent.

(3) The provision of three round and three flat bars for every batch of castings is irksome to the manufacturer, particularly when the quantity of castings ordered is small.

(4) The inspector must rely on the integrity of the manufacturer as to whether the test bars were cast at the same time as the castings and annealed with them.

(5) The specification is not designed to cover castings suitable for electrical or magnetic induction purposes.

(6) The specification does not distinguish between castings for high or low-grade work. In many cases, such as ironmongery, castings of lower specification, and hence cheaper material, would be suitable, whilst castings upon which life depended, such as automobile work, require a different specification.

Many of these objections could be overcome. A suggestion put forward by the British Cast Iron Research Association was to use a different-sized test bar to represent various castings. The sizes suggested were 0·253in., 0·564in., and 0·977in. diameter, the two smallest to be used for white-heart and thin-walled castings, and the two largest for black-heart and thick-walled castings. The Sub-committee suggested that the use of a standard-sized test bar with varying requirements might also be considered. Thus, it might be possible to use the standard 0·564in. diameter bar with a higher specified ductility when used with thick castings requiring very thorough annealing, and a lower ductility (and possibly higher strength) when used with thin, small castings requiring less annealing.

But mechanical testing alone could not overcome all these difficulties, and a suitable microscopical examination, either in conjunction with the B.E.S.A. (B.S.I.) specification or alone, could possibly be evolved to give satisfaction in all cases.

The Sub-committee is now considering:—

(1) The use of varied-sized test bars to suit the type of casting.

(2) The use of a standard-sized test bar in conjunction with varied requirements to suit the type of casting.

(3) The possibility of having more than one standard grade of malleable.

(4) The effect of and the inclusion in the specification of a repeated impact test.

(5) The creation of a specification covering a test for castings for electrical work, where properties, such as magnetic permeability, are of greater importance than tensile strength.

(6) The inclusion of a clause covering the after-treatment of malleable, such as welding, brazing, or galvanising, this particularly to be a guide to the buyer as to what he may expect from malleable cast iron.

(7) The creation of a microscopical specification and its application—(*a*) in conjunction with standard mechanical tests, (*b*) as an acceptance test, and (*c*) as a means of investigating service failures in cases where the original mechanical test results were satisfactory.

The Sub-committee expresses the view that the use of varied-sized bars to represent varied-size castings is a step in the right direction, but points to various problems in the way of its successful adoption. It cannot agree to the generalisation in the B.C.I.R.A. paper that light castings are usually white-heart and heavy castings black-heart. It suggests therefore that the same range of test bars should be used for both types of malleable.

Due consideration shows the futility of working to the same specification for castings to be used under widely varying conditions. It has been decided that recommendations should be made in respect of agricultural castings, aircraft, automobile castings, colliery work, electrical work, engines, general ironmongery, lifts, cranes, conveyors, &c., machine tools, textile machinery, railways, and shipbuilding. This, however, could not be done until the present preliminary examination was completed, and the testing conditions standardised.

It has been decided that no immediate further work shall be undertaken on the mechanical testing of malleable unless a request be put forward by the manufacturers, buyers, or other bodies (in which case the results already

obtained will be available), but that the immediate future work of the Sub-committee shall be a full microscopical investigation of various types of malleable with a view to correlating the micro-structure with the mechanical properties.

## Paris Gas Congress.

THE Annual Congress of the French gas industry was held last week in the Conference Hall of the Société des Ingénieurs Civils, whose building adjoins the Maison du Gaz in Paris. There was a large attendance, including representatives from Great Britain. About twenty communications were presented, besides reports by the different commissions, one of them dealing with the dangers arising from possible accumulations of gas in the conduits carrying the electric cables of the Post and Telegraph Department. The conduits are composed of concrete slabs, 1 m. long, pierced with four moulded holes through which the cables pass and they are recessed for alignment and joined with cement. At intervals there are concrete pits or chambers of various sizes and forms, some with manholes and others entirely closed. Many accidents have occurred through leakages from gas mains passing into the conduits and accumulating in the pits or chambers where the cables are joined up, and the gas is even carried to buildings at the extremities of the lines, where explosions are always possible. Precautions have already been taken to make the conduit leak-tight, and several types of joints are suggested in the report, but equal importance is attached to ventilation and regular inspection, particularly of the enclosed underground chambers, where it is proposed to fix a vertical tube rising close to the surface and covered by a plug, so that by removing the plug it will be easy to detect any trace of gas. The Post Office is experimenting with concrete slabs, 100 m. long, moulded on four leather hose under water pressure, and when the concrete sets the hose is withdrawn by pulling forward the rear end, so that the hose is turned inside out.

Most of the reports dealt with distillation plants, recuperation, cleansing, and purification, and the necessity of adopting a uniform type of small gas meter working under more satisfactory conditions than at present. The domestic user in France has often cause to complain of the erratic results obtained with his meter. The attempts to eliminate all risk of leakage from gas mains were dealt with by Monsieur B. Walckenaer, who said that the manufacture of steel tubes nowadays was so far perfect, alike as regards the quality of the metal, its homogeneous character and protection from rust, that the only serious trouble arose from the joints, and in the past authorities had gone so far as to affirm that from 20 to 40 per cent. of the gas was lost by leakage. The old lead and fibre joint is disappearing, and when rubber began to be used, the results obtained were so far satisfactory that it was believed to have provided a complete solution of the leakage problem. Experience has modified this view, and rubber rings have deteriorated through shearing stresses and friction caused by the relative movements of tubes, while trouble has arisen from the quality of the rubber employed, and sometimes also by the effect of acids. This material is, nevertheless, the only one that allows of flexibility and longitudinal movements, and it will continue to be employed, though makers of such joints will not cover them with a full guarantee. Monsieur Walckenaer described some of the flexible rubber joints in use. In all cases the rubber is under considerable compression, and it may be asked whether better results as regards durability may not be obtained with joints in which rubber rings work with a sufficient elastic range. The commission is investigating the durability of rubber joints, though it will probably not be able to collect all the practical and experimental data enabling it to come to a definite conclusion for a considerable time. Meanwhile, Monsieur Walckenaer is of the opinion that the only safe solution lies in continuous tubes welded end on end, the line being sufficiently flexible for the sinuous laying of mains and for giving to any moderate sinking of the soil. The weld should be relieved of all stress by expanding one end to form a spigot and socket arrangement, and where special allowance must be made for expansion and contraction, corrugated tubes may be provided. In France the use of overlapping welded joints is spreading, particularly in the Nord and the Pas de Calais, where a considerable length of gas mains has been laid down during the past few years. As one associated with the laying and maintenance of gas mains, Monsieur Walckenaer deprecates the use of joints that are stronger than the tube, because it would be better, he says, for the joint to give way than for the tube to burst.

Gasworks in small towns, where the mains have to be extended to outlying and sparsely populated districts, have a difficulty in getting an adequate return with their relatively high capital and maintenance charges, and two papers were presented showing how such gasworks had succeeded in building up a profitable business in the supply of tar for road surfaces. The requirements in France for such purposes amount to something like 600,000 tons a year, and it is obvious that each district would find it more convenient to obtain suitable hot tar from local gasworks than to procure outside supplies. Monsieur A. Eichelbrenner described what had been done at the Montbéliard gasworks, where a Woodall-Duckham continuous distillation plant had been laid down, and the Ponts et Chaussées had decided to construct three 200-ton storage tanks, one at the gasworks and the others 6 and 12 miles away, which the gas company would keep supplied with hot tar. Monsieur F. Descours explained how the gasworks in the small town of Gap had gone still further, and, by acquiring a complete plant for tarring road surfaces, had become contractor for road maintenance in the adjoining district. This enterprise had proved entirely successful, and profitable, and it showed how small gasworks in country towns could turn a financially precarious gas supply into a remunerative business.

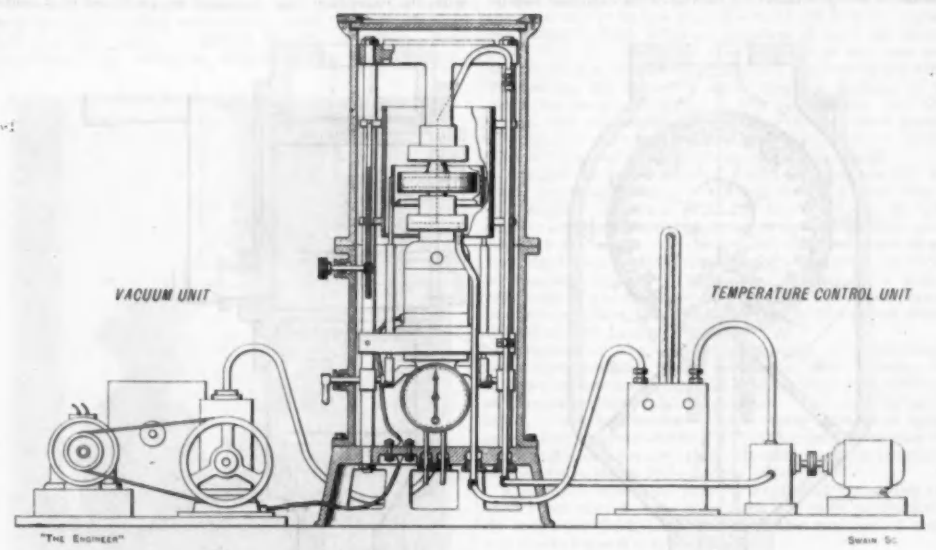
The use of gas for industrial purposes has made less headway than can satisfy the producing companies, the reason given by those who have tried gas being that the cost is too high, while the companies affirm that consumers do not know how to use it properly. Monsieur A. Denus illustrated cases that he had investigated where the installations gave an efficiency of only 15 to 20 per cent., and nowhere did it exceed 30 per cent. Monsieur Denus took these cases in hand and modified the plants so as to effect an economy in gas consumption of 50 per cent. and more. In new installations designed by gas engineers better results may be obtained. This experience shows the necessity of gas engineers being in close touch with industrial users, for without their aid there will always be dissatisfaction over the gas consumption. Monsieur S. Brull dealt with the advantages of gas furnaces in iron and steel works and engineering shops, particularly on account of the control of temperature over a wide range, and he produced a complete statement of costs showing the economy of town gas. He believed that his statement, by enabling the user to work out his costs according to the local price of gas, would help to extend the employment of that fuel, which was ideal in view of the precision of the results obtained. Monsieur J. Brodin described the "Tourbillon" furnace of large capacity, designed upon the principle of "superficial combustion." Small furnaces are being used in which the gas burner projects the jet tangentially against the roof, which becomes incandescent, and the gases then descend by the walls to the grate and leave by the chimney, but this is the first furnace of the kind in which a 100-ton steel ingot has been heated, and as it is believed possible to increase the temperature of 1200 deg. Cent., the furnace may, it is said, be capable of dealing with 160 tons of metal. It has been in operation since December, 1930, and it is stated that it has undergone no deterioration. When heating an ingot, 5 m. long and 2·15 m. diameter, it took 5½ hours to bring the furnace to a temperature of 1000 deg. Cent., and it was heated at a temperature of 1200 deg. Cent., for 18 hours, and then remained a further 8 hours for stabilisation. The total consumption of coke oven gas was 9885 cubic metres. The inside dimensions of the furnace are 2·6 m. high, 2·9 m. wide, and 8·32 m. deep.

As showing that there are no serious difficulties in the laying of gas mains across estuaries where the water is liable to be rough, Monsieur Picard described the work of laying a pipe line in the Etang de Berre, which opens to the Mediterranean, for the oil depôt of the Union des Pétroles de Martigues. There were four tubes, three of 250 mm. diameter and one of 300 mm., which had to cross a canal, and then pass on to a mole which had been constructed 600 m. from the shore of the Etang de Berre. There were difficulties owing to the restricted space available for assembling the tubes. Lengths of 135 m. were screwed by clamping down the male tube and rotating the female tube on rollers by means of an expanding mandril inserted at the end of the tube and turned by a pulley and reduction gear. The pieces were then closed with blank ends and floated out to a neighbouring yard, where a sea wall allowed of the lengths being brought together and connected with right and left-hand threaded sleeves. All the connections were made leak-tight by welds. The line, with vertical terminal tubes, was towed out to the mole, partly on rafts, and was immerged rather precipitantly to avoid bad weather. The work was carried out successfully, and pumping from tankers began in February last.

Visits were arranged during the Congress to the Clichy gasworks and to the Office National des Recherches et Inventions, and after the close members journeyed to Dijon, where they were received by the Municipality and inspected the new gasworks, while another day was devoted to visiting the vineyards.

## The Sperry-Cammen Tester.

IN the accompanying engraving we illustrate the Sperry-Cammen tester, which is referred to in our leading article on "A New Theory of Lubrication." It will be gathered that the rotor, surrounded by an oil-collecting cage and a shield runs inside a vacuum chamber. The rotor, of steel, bronze, or other metal, is hollow, and through it a stream of fluid is circulated in order to control the temperature conditions. The speed of the rotor is stated to be capable of being varied between 1000 and 18,000 r.p.m. Its diameter is given as 10in. The oil to be tested is applied to the periphery of the rotor, and the extent to which it is thrown off as the speed is increased is noted. In a specific instance mentioned in Messrs. Parish and Cammen's paper, it was found that a film of lubricant still adhered to the rotor when the speed was 8000 r.p.m. At that speed, it is calculated, the centrifugal force on the oil film amounted to 9070 lb. per lb. of the lubricant.




THE SPERRY-CAMMEN LUBRICATION RESEARCH APPARATUS

## SIXTY YEARS AGO.

OUR recent note on the Tay Bridge produced an interesting letter from a correspondent who recalled the theory which he formed at the time concerning the cause of the disaster to the structure. Our correspondent and others will, no doubt, be interested to learn that in our issue of June 28th, 1872—at which date the bridge was in the early stages of construction—a letter appeared in which a feature of the design was criticised and in which the possibility of a serious accident was specifically mentioned. The letter was signed by Mr. H. Nabholz, of Ernst Reuss and Co., Manchester. Mr. Nabholz was closely interested in the design of the bridge, for eighteen months previously he had been engaged by the firm which "ought to have carried out" its construction. He agreed with the calculation made by Mr. A. D. Stewart—Bouch's collaborator in the design of the structure—for the stresses in the members of the main girders, but he pointed out that the section of the top, or compression flange, was trough shaped, consisting of three plates, forming the three sides of a box, and four angle irons, two in the internal angles of the section and two stiffening externally the lips of the trough. The total section of the trough omitting the rivets was, our correspondent said, 28·5 square inch. At the centre of the span the total load on the compression flange was 150 tons, and, hence, the compression over the trough-shaped section amounted to 5·26 tons per square inch. The top flange was supported at intervals of 25ft. by the diagonals of the web bracing. Mr. Nabholz was concerned about the omission of any bracing uniting the angle irons which formed the lips of the trough. The possibility occurred to him that under the load of 150 tons the two angle irons at the internal corners might splay out to something more than 90 deg., thereby converting the parallel-sided trough into one with divergent sides. In short, he feared that under the load the trough-shaped compression flanges would double up. He urged that a full-sized member of the same trough section and 25ft. long should be set up and tested in compression. In our succeeding issue Mr. Stewart replied to our correspondent. He pointed out that Mr. Nabholz was wrong to the extent that the area of the trough section, which he had named, applied only to those parts of the girder at which the load was less than 100 tons. At the middle of the span the section was increased to 40¼ square inches, which gave a load intensity of 3·8 tons per square inch. As for the possibility of the method of failure indicated by Mr. Nabholz, Mr. Stewart wrote nothing in denial of it, but contented himself with an assertion of his belief that the trough-shaped form of the compression flange combined "the greatest facility of construction with the greatest possible rigidity and strength."

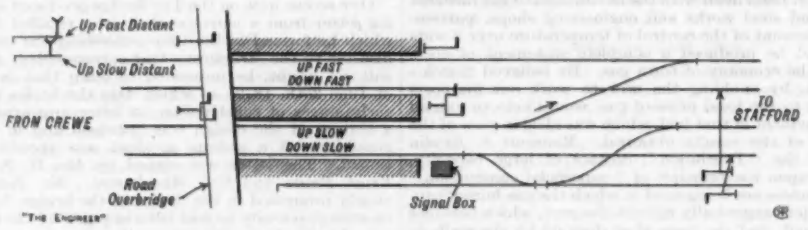
## Derailment at Great Bridgeford.

THE first fatal passenger train accident in this country this year, and the first for exactly six months, occurred on Friday evening last, June 17th, at Great Bridgeford, L.M.S. Railway, nearly 3 miles north of Stafford on the Crewe–Stafford main line.

The train concerned was the 7.23 p.m. express from Crewe to Birmingham, which consisted of four bogie coaches and an open carriage truck in the rear. It was drawn by 4–4–0 engine "No. 5278," which bears the name "Precursor," as being the first of Mr. George Whale's "Precursor" class, and was built in March, 1904. The train ran on the up slow line as far as Great Bridgeford, and was being turned through the single crossover junction on to the up fast line, when the engine was derailed, turned on its left side, skidded along and embedded itself in the embankment on the up side of the line. The two leading coaches were telescoped. Four passengers were killed and among the seriously injured was the driver.

The coroner's inquest was opened on Monday, the 20th,

and adjourned indefinitely. The Ministry of Transport inquiry was held on Wednesday. It was conducted by Lieut.-Colonel Mount, who was assisted by Lieut.-Colonel Woodhouse. At the opening of the proceedings, Colonel Mount observed that as questions affecting the conduct of some of the men concerned might arise, and evidence on those points might incriminate some of the men, he proposed to hear only the technical evidence in public; the remainder of the evidence would be heard in private.




SITE OF THE GREAT BRIDGEFORD DERAILMENT

It was then shown that the engine was built in March, 1904, and the last time it underwent general repairs was in March, 1931, after which it was placed out of service until December, 1931, since which it had run 18,855 miles. An inspection of the locomotive after the accident showed that the tires were of good thickness and the flanges excellent. As far as could be ascertained, the gauge of the wheels was very good, except that the driving wheels were $\frac{1}{16}$in. tight. A more complete inspection of the engine was to be made by Captain Beames, and the result would be forwarded to Colonel Mount.

Considering the punishment it had to endure by the speed of the train through the crossover junction, remarkable testimony was given as to the condition of the line after the mishap. No repairs had to be made to the facing points in the up slow line nor to the intersection with the down fast line. Thereafter the rails were pushed 1$\frac{1}{2}$in. out of position, but no keys were cut and the chairs had not moved. Beyond that the track of the up fast line was damaged for 99 yards. The signalling and interlocking were tested immediately after the accident and were found to be quite correct. The signal and telegraph local representative said that he particularly satisfied himself as to the accurate working of the up slow distant signal.

At this stage the reporters were requested to withdraw, and the rest of the evidence was given in private. The inquiry was then to be adjourned until the driver can give his testimony.

## A New Self-Cleaning Strainer.

OWING, possibly, to the increased use of the oil engine, the lubricating and fuel oils for which must be very carefully strained, there has been a tendency of late years towards the production of self-cleaning strainers. We have described several types in our columns at various times. The strainer illustrated by the line and tone engravings accompanying this article has recently been put on the market by Ashworth and Parker, of Bury, Lancashire. It is claimed for it that it has marked advantages over other types. As in other self-cleaning strainers its self-cleaning action depends upon a high-pressure reverse flow, but the method by which this flow is brought about is novel.

Referring to the drawing, Fig. 1, it will be seen that the filter itself is mounted upon a drum, which is capable of rotation upon spigots in the end covers. The drum is equipped with internal teeth which engage with those of a pinion supported in plain bearings at each end and capable of being rotated by means of an external handle.

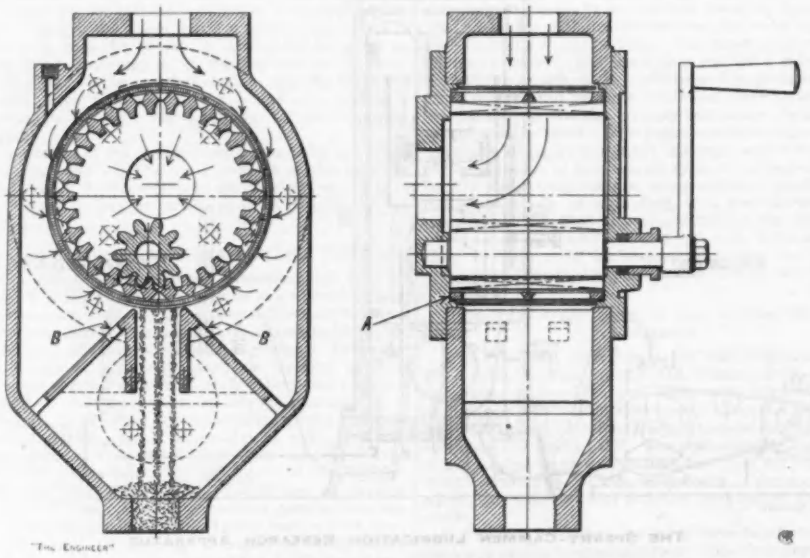



FIG. 1—SECTIONS THROUGH SELF-CLEANING STRAINER

The axis of the drum is horizontal and the pinion is set a little off the centre line of the filter box at the bottom of the drum. The liquid enters from the top or any other convenient point and passes inwards through the filter drum towards the centre, so that dirt, grit, &c., is deposited on the outer face of the strainer. By rotating the pinion the oil trapped between two teeth of the internal teeth of the drum is forced outwards, carrying any adhering dirt with it. Thus, it will be seen that the filter is cleaned section by section. In the majority of the filters made by the company three turns of the handle are sufficient to clean the whole filter. In the larger sizes, however, the gearing has a lower ratio. It is claimed that by thus cleaning the filter by sections, the action is more efficient. When a whole filter is subjected at one time to reverse flow there is a tendency for the oil to seek the easiest path—that is, to pass through those parts of the strainer upon which least matter has been deposited. In this filter it will be seen that each separate section receives individual attention.

A fault that must be guarded against in all strainers that depend for self-cleaning action upon reverse flow, is that of re-picking up the material released, as soon as normal flow is re-established. If time is not given for the matter in the oil to settle re-deposition may easily occur. In the strainer under consideration special measures have been taken to guard against any such happening.

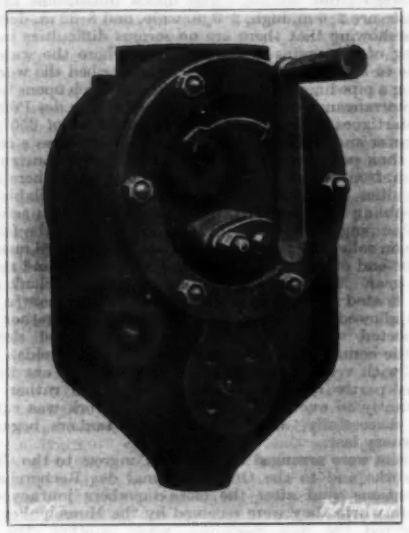


FIG. 2—ROTOKLENE STRAINER

Referring again to the drawing—Fig. 1—it will be seen that the box housing the filter is divided into two compartments. The oil displaced by the action of the cleaning pinion is forced outwards and downwards into the lower of these compartments, from which it cannot pass back through the filter owing to the sealing effect of the pinion teeth. The section of this lower compartment is very similar to that of an old-fashioned, unspillable ink bottle, with the exception that passages are provided in its sides to allow the oil to pass from it into the upper compartment. The volume of the compartment is very much greater than that of the oil displayed by a rotation of the pinion. In consequence, the dirt and grit in the oil displaced from the filter has plenty of time to settle out before the oil passes back through the holes B into circulation again.

The makers also fit, where desirable, a special indestructible filtering cartridge. A thin and narrow strip of material of square or rectangular section has V grooves of a depth corresponding to the fineness of straining required, rolled transversely into one side. The strip is then wound closely together on a mandrel of about the same diameter as the strainer drum in such a way that the V grooves are radial. The construction can be seen in Fig. 3. It is claimed that the strainer so formed can be constructed with spaces finer than the finest gauze cloth, and that it is at the same time very much stronger and not liable to be damaged by grit or carried away by excess pressure.

The makers term the new filter the Rotoklene strainer. It is suitable for paints, size, dies, inks, chocolate, &c., besides lubricating and fuel oils, and is built in various

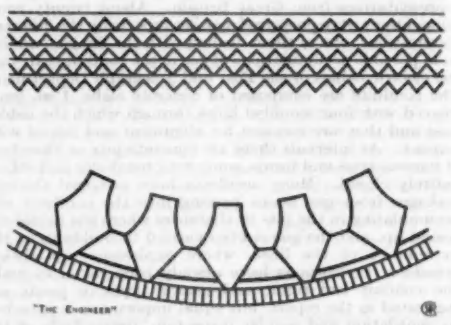



FIG. 3—INDESTRUCTIBLE FILTER CARTRIDGE

sizes. Two or more may be arranged axially in line in the same box, if desired, to form a duplex arrangement, which calls for a slight modification of the design of the settling compartment.

## Monotower Cranes for Lochaber Power Scheme.

IN our issue of March 4th, we published a brief description of the progress being made with the Lochaber power scheme and referred to the two cranes and interconnecting bridge which are being used for the construction of the dam across the river Spean for impounding the waters of Loch Laggan. The cranes, illustrated herewith, are of the Butters monotower type, and are carried on steel towers 16ft. square with a height of 165ft. above foundation level. They are of 7 tons capacity and are fitted with jibs 110ft. long. They are capable of lifting their full load at a radius of 80ft., and have a maximum radius of

MONOTOWER CRANES

110ft. Being of the monotower type, the cranes revolve in a complete circle, each crane covering an area of 38,000 square feet. With the jibs operating at an angle of 45 deg., they have a total lift from foundation level of 220ft. Each crane is operated by a single motor of 60 B.H.P., the one motor operating the lifting, slewing in a complete circle, and derricking gears. An interconnecting bridge is carried from the south side to the north side of the river, the centre span being 200ft. long, and each end span 100ft. long. This bridge carries a 3ft. gauge railway for running the contractors' rolling stock across the river. The bridge is connected to the towers of the crane at a height of 75ft. above foundation level. The rolling stock runs through a portal constructed in the towers of the cranes. The cranes and bridge were supplied and erected by Butters Bros. and Co., of Glasgow, and are the first of their type to be used by contractors for the construction of work of this nature. The equipment was constructed for Balfour, Beatty and Co., Ltd., London, who are the contractors for the carrying out of the whole of the work. The consulting engineers responsible for the scheme are Messrs. C. S. Meik and Halcrow.

## A New Grab.

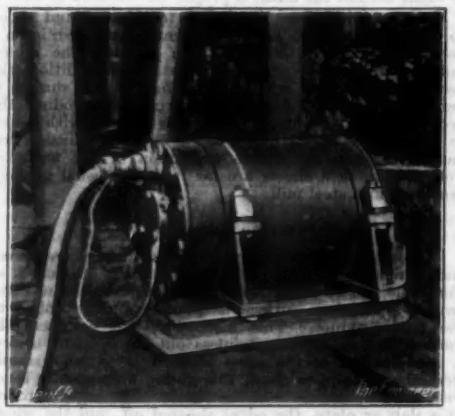
A NEW design of grab, which is being manufactured by the Demag Aktiengesellschaft, of Duisburg, is illustrated by the accompanying engraving. It somewhat resembles the orange-peel grab in its action, but may have as many as eight grabbing arms, and is worked by means of two ropes, one for lifting and the other for closing. In the illustration there appear to be three ropes, but they really act as two, for the two outside ropes form the bight of the closing rope and act as one. The grab arms are pivoted to the movable bottom block and are attached to the top block by links. The joints are such that the arms can be moved in all directions, and the makers state that the grab will adapt itself to the shape of the article being grabbed. The arms are, naturally, so shaped that they will conveniently grapple with the

MULTIPLE ARM GRAB

material to be handled, even if it be scrap metal as shown in the illustration. The company makes these grabs in a large variety of sizes with capacities ranging up to about 15 tons, or 20 cubic yards.

## Flame-Proof Motors.

WHERE apparatus for use under Rule 132 of the Coal Mines Act comes under the heading of portable apparatus it must be completely flame-proof, and to meet this requirement the Metropolitan-Vickers Electrical Company, Ltd., has developed a special series of squirrel-cage motors ranging from 2 to 25 horse-power. The two smallest machines have fixed supports, but all the larger motors

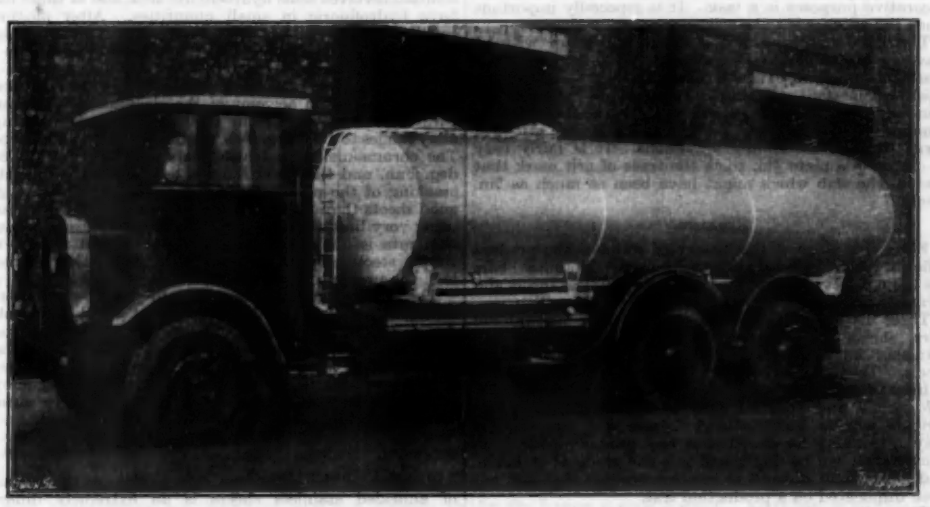


FLAME-PROOF MOTOR FOR MINES

are provided with detachable feet, so that they may be rolled along the ground. The accompanying illustration shows one of these motors used for driving a conveyor at the Ashington Colliery. The terminal arrangement may take the form of a 30-ampère plug and socket mounted on the end bracket, as shown, or it may consist of a starting and reversing switch mounted on the stator and capable of taking an incoming trifurcating box, a 30-ampère plug and socket, or a 100-ampère B.E.S.A. plug and socket. When a switch is fitted arrangements are made to enable it to be easily removed so that the motor may still be moved from place to place in the manner described. The shell and end brackets of these motors are composed of stout steel boiler plate, capable of withstanding great outside pressure. Ball and roller cartridge type bearings are fitted with dimensions from 20 to 50 per cent. greater than the accepted sizes on such motors. The rotor is of the solid cast indestructible type, designed to give exceptional starting torque characteristics. Feet fixing arrangements vary from end bracket supported feet to circular strap feet or a combination of both to suit a variety of dimensions. The use of separate feet enables the motor to fit any of the usual types of conveyors, &c., and leaves the colliery manager a free choice of the type of mechanical drive. A pamphlet just issued by the Metropolitan-Vickers Electrical Company deals with the choice of motors for mining service and describes the various classes of motors that have been developed for use on the surface and underground.

## 2300-Gallon Tank Wagon.

THE accompanying illustration shows one of the 2300-gallon tank wagons, two of which are being supplied to Cow and Gate, Ltd., by John I. Thornycroft and Co., Ltd. These wagons will be used for transporting milk from the company's dairy centre to the milk foods manufactory. The stainless steel tanks, supplied by Thompson Bros., Ltd., of Bilston, are of elliptical section, 6ft. 3in. by 4ft. 2in., and are 18ft. 5in. long. The steel is covered first



TANK WAGON FOR MILK

with a 2in. lagging of aluminium foil ("Alfol") and finally with light-gauge aluminium sheet. The chassis is Thornycroft's six-cylinder "Q.C. Forward." The equipment includes a rotary pump driven from a power take-off in the gear-box and a tubular ladder and light platform which give access to the stainless steel lids of the two manholes.

## A Safe Load Indicator for Cranes.

To meet the demand for a safe load indicator for cranes employed on building construction work, John M. Henderson and Co., Ltd., of King's Works, Aberdeen, have introduced the indicator shown in the accompanying

LOAD INDICATOR FOR CRANES

illustration. Approved by the Home Office, it gives a visible and audible warning to the driver when the safe load of the crane is exceeded for any radius. The radius is indicated on the left on the graduated quadrant by the radius indicator pointer, which is moved by rods connected to a point at the foot of the jib, whilst the load indicator is operated by the hoist rope deflecting roller. The load on the roller varies in proportion to the load on the hook and is transmitted to a spring through levers and connecting-rods. The deflection of the spring under load moves the load indicator pointer and indicates on the right-hand quadrant the load on the hook.

Between the minimum and the maximum radius for full load, the danger quadrant is stationary and in this position a warning mark on the danger quadrant coincides with the graduation for the full load on the load indicator quadrant. When the load indicator pointer moves past the warning mark a gong rings. As the radius increases beyond the maximum radius for the maximum load, the safe load for the crane decreases and the danger quadrant moves up. The warning mark then coincides with the graduation for the load which the crane is capable of taking at the increased radius and the gong rings if this load is exceeded.

## Gearless Electric Clock.

A VERY interesting form of the now popular electric frequency clock is being developed by the Westinghouse Electric Company in America.

While the idea is still in the experimental stages and is not commercially available, the fact that it is practical and workable has already been demonstrated.

One feature of the clock is that it has only four moving parts, each of which operates one of the hands. The fastest of these revolves only sixty times a minute.

All the mechanism is visible through a celluloid face about 10in. in diameter. The mechanism stands about 6in. high from the box containing the condensers and resistor, which produce a rotating magnetic field.

Just below the outer rim of the clock face is a wire-wound iron circle known as the stator, which is so wound as to produce a magnetic field rotating 3600 times per minute. It has 118 iron teeth around its inside edge. Inside this ring, near it, but not touching it, is the rotor, around the outer edge of which are 120 iron teeth. The tendency of the magnetism is to jump across from the stator to the rotor and to do this when the teeth are directly opposite each other. With different numbers of teeth on the two parts, only two teeth are synchronised at any one time, and there is a vernier effect around the rest of the circle. This causes the motor to move only the distance of two teeth for each revolution of the magnetism. In other words, the magnetism is whirling around 3600 times a minute, but the rotor revolves only sixty times a minute. This is the speed required for a split second hand.

Around the inner edge of the rotor ring are 122 iron teeth pointing toward a second rotating iron ring of still smaller diameter with 120 teeth around its outer edge. In this second reduction of speed the first motor becomes the stator for the second, but while the first is running forward sixty revolutions a minute, the second is running backward fifty-nine revolutions a minute relatively to the first one, so that its net progress forward is one revolution per minute. This is the speed desired for the second hand.

Attached to the second hand rotor is a permanent horse-shoe magnet which creates a new rotating field in 118 iron teeth driving still another ring with 120 teeth at the rate of one revolution per hour. This runs the minute hand. Attached to the minute hand rotor is a second permanent magnet creating a rotating field in twenty-two teeth and driving a twenty-four-tooth rotor one revolution every twelve hours for the hour hand.

The entire operation may be explained by saying that each rotor travels only two teeth for each revolution of its magnetic field. By changing the number of teeth, any desired speed may be obtained.

ACCORDING to Dr. H. J. van der Bijl, the Pretoria Iron and Steel Works can figure on an annual consumption of about 400,000 long tons of steel products of the classes it is proposed to make, i.e., rails, sheet bars, sleepers, building sections, billets, merchant bars, reinforcement and wire rod, and including articles which can easily be manufactured in South Africa from steel produced at Pretoria, and of which considerable quantities are already being manufactured locally, such as steel ceilings, bolts, nuts, nails, and pipes.

# Stainless Iron and Steel Production.*

No. II. (*Conclusion*).†

### Surfacing.

In preparation of surface of stainless alloys two things are encountered. The surface is full of small defects due to the limited scaling and consequent lack of removal of the very small scabs and cracks. The decarburisation is usually followed by very large crystalline grain growth which is very fragile. For this reason it is necessary to remove not only the visible defects, but also enough of the underlying material to ensure a surface that will roll. The amount removed varies, but usually an arbitrary depth of metal is removed. The European practice was to machine about ¼in. depth from surface of ingots less than 16in. across. American practice favours removal of billet surface, and this is best done by grinding. Chipping is resorted to on the austenitic steels, where very heavy forgings are to be made, or the surface of the bar removed by turning. Machine removal of the whole surface is sometimes done with milling machines or planers. Grinding is the method usually used, and is best done with powerful high-speed grinders. If the usual surface removal is all that is required, a high-speed wheel using an organic bond is used. The grit will depend upon the surface required, but much of the work is done with about sixteen grit rubber bond wheels travelling at a speed of about 9000 surface feet. If much rough work is to be done, vitrified bond wheels with coarse grits and slower speeds are used to rough. In either case the bond must be such that the wheel does not glaze. Surface preparation of a product that is to be used for decorative purposes is a task. It is especially important when the product is to be rolled into strip or sheet.

The large flat areas are hard to touch up without leaving very definite differences. The first grinding must be done with extreme care. The usual scaling and oxidation present on simple steels is absent and the grinding must be done in such a way that no fine shavings remain. Even the marks of coarse grinding grit will carry through the rolling operations. It is fairly easy to detect in a plate ½in. thick the trace of grit mark that was on the slab which might have been as much as 2in. thick.

### Rolling.

From this stage of the history of stainless the product follows two widely divergent courses. Stainless bars are the product of one type of mill, and stainless sheets and strip are produced under a different system of rolling.

Three major groups of finished product are encountered bars, sheets and strips. Within its field each group furnishes all the usual finishes encountered in simple steels. Thus, we have hot rolled, cold drawn, ground, polished bars in annealed or treated states. We have cold rolled and polished sheets. We have cold rolled strip in a wide assortment of finishes and tempers. It may reasonably be stated that any product made from simple steel can be duplicated in some grade of stainless, and it would be difficult to locate a product that had not been duplicated on a production test.

The rolling of stainless steel into bars is a process more fitted to the flexibility of the tool steel mill lay-out than the big production continuous mill method. The usual order is very small in tons. The risk involved in attempting to produce under conditions encountered in simple rolling is too great. The most satisfactory plant equipment is a special small-scale lay-out, usually hand mills. The furnaces must be of ample capacity to account for the low heating rate. It is usual to find even the tool steel heating methods too fast for proper soaking of such materials. In usual practice the heating must be slow until the grain growth temperatures are reached; providing for thorough soaking and rapid heating from grain growth temperature to rolling temperature. The heating cannot be done by rushing to the rolling temperature and soaking there, since the time required to soak to the centre will cause decarburisation or grain growth, and usually both. Small lots of steel, good pyrometric observation and small batches working to ensure proper handling before the next lot is in the critical stage are only sensible precautions. The mill lay-out and method of rolling must account for certain characteristics of the product. Since the heavy jacket of scale common to ordinary steel is not present the surface is easily marred. Any sliver or scratch or mark is not immediately smoothed over by the oxidation of the surface. Any sheared portion does not oxidise off; it remains to be worked in or dragged off in guides, or the floor. For this reason the guide mill method is less desirable than the hand round. The finest of the tool steel practices are justified and should be used where possible. Since all the more important bar sizes can be produced by the hand round method and the smaller sizes by very well-handled guide mills, only the rod sizes are subject to the definite hazard of fast reduction and tight guides all the way. Rod sizes are best produced by using billet sizes as small as possible and producing relatively heavy rods. Each coil should be inspected as produced to make sure the guides are clean. This slows the production very definitely. Careful operation of a mill will permit production of rod sizes down to ¼in., and considerable material is produced as small as 0·220in. where the surface and section can stand some slight defects. Where the combinations of chemistry do not permit wide ranges of working temperature the only recourse is to very small billets and very rapid work with a limited number of passes.

The rolling of strip is best accomplished in the older type of strip mill equipment. The low carbon chromium is usually heated to furnace temperatures of about 2000 deg. Fah. and finished above 1500 deg. Fah. The chrome-nickel material is started somewhat hotter up to 2150 deg. Fah. and finished much hotter, approximately 1650 deg. Fah. It is customary to roll the straight chromium strip to much thinner gauge, due to its softness. With a given mill and nearly similar set-up the chrome-nickel will be 30 to 40 per cent. heavier.

Broad flat areas are encountered in strip slabs and every precaution to prevent scaling must be taken. The refractory character of the scale formed, if much oxidation is present, causes it to punch into the surface of the strip. The resulting product is very rough and unsuitable for cold rolling. Pressure water cleaning during roughing passes, is very useful, but must be of very high pressure and applied for a very limited time.

Stainless sheet rolling is carried out on mill equipment similar to that used for simple sheet materials. An essential difference early noticed is the heating equipment. The working temperatures are higher. The furnaces must be free from dust and dirt. The usual equipment is gas-fired and the care of operation is in keeping with the value of the product. The production of plates for sheet bar is usually carried out on a light plate lay-out. The working temperatures for the slabs are higher than for common steel and the product requires more passes since it is harder at temperature. The range of working would be highest in the alloys of the 25 chromium 20 nickel type, in which case it is close to 2000 deg. Fah. The limitation is usually the temperature at which contaminating dust and dirt begin to fuse on to the surfaces. The chrome-nickel iron series of the 18 chromium 8 nickel class are rolled to plates a little lower, since they are soft enough at 1800 deg. to 1900 deg. Fah. The 18 chromium and the lower chromium types roll at slightly lower temperature, being quite soft at 1800 deg. Fah. The plates of all grades are flattened hot and sheared to sheet bar sizes, usually with some heat still in the plate. The surfaces are pickled free from scale. Hot rolled surfaces pickle in sulphuric acid, although the usual pickling solution involves some hydrochloric acid, and at times may have hydrofluoric in small quantities. After pickling, small defects on the bar are ground off with hand grinders using rubber bond wheels and fine grits—20 to as fine as 40 grit being used.

The actual sheet rolling is done with gas-fired furnaces, where possible, on account of the cleanliness. The temperatures used range from 1900 deg. Fah. for the high alloy ranges to 1500 deg. Fah. for the low chromium ranges. The chrome-nickel austenitic material is started at 1800 deg. Fah. and the lower limit is determined by the edge cracking of the pack. Since it is more important to get good sheets than tonnage, the precaution of reheating and using very limited passes is practiced. The usual production rate is about one-third that considered normal for simple steels. Since the volume of production is much less, the problem of roll shape is more pronounced.

The sheet products divide into three classes—the straight chromium steels, which must be slowly cooled during annealing to ensure softness by absence of martensite; the austenitic chrome-nickel steels, which are quenched, or rapidly air-cooled when thin, to ensure complete austenitic structure; the heat-resisting alloys, which are usually cooled in such a way as to ensure workability, air cooling being the common method.

### Pickling.

Pickling of the chromium iron oxides on the surfaces of annealed stainless sheets is an extremely difficult operation. A stainless sheet is a highly corrosion-resistant material. The scale on the surface is tight and very insoluble. The surface of the sheet must not be marred and the product is extremely expensive. Many methods of pickling have been used. In any plant producing many grades of stainless for various applications several may be used regularly. As previously stated, hot mill scales are usually soluble in sulphuric acid in concentrations of 10 and 15 per cent. by volume at temperatures about 165 deg. Fah. When annealed, the scale is much harder to dissolve, and quite commonly the mixture for rough pickling will contan 10 to 15 per cent. sulphuric acid and 5 to 25 per cent. hydrochloric acid by volume. The temperature will approximate 165 deg. Fah. Since these very active pickling baths over-etch easily, the job is not completed. The scale is rotted, the sheet removed, the sludge scrubbed off and a milder solution used. Finish pickling solutions may be hydrochloric followed by nitric, hydrochloric and nitric followed by nitric, nitric and hydrofluoric or nitric hydrofluoric and hydrochloric. For clean grey surface pickling, a mixture of 10 per cent. commercial nitric by volume carrying 2 per cent. hydrofluoric is very satisfactory. The operating temperature should be kept low—that is, below 130 deg. Fah. Agitation is not satisfactory. Following the removal of scale the sheet should be immersed in 10 per cent. nitric by volume at about 130 deg. Fah to render the surfaces passive. Where a brilliant metallic lustre is desirable, the nitric hydrofluoric mixture should carry about 1 per cent. hydrochloric. The hydrochloric acid mixture is very prone to over-etching and must be handled by very skilful picklers. In all cases the final operation of pickling should include nitric acid for passivation of the surfaces.

### High Finish and the Tension Mill.

The sheets used for decorative work, or where appearance is vital, are cold rolled to produce high finish. The product is very hard and the usual cold rolling methods are not satisfactory. Backed up mills of the four high or cluster type using very hard polished steel rolls are needed. The pressure possible with ample size equipment permits reduction of one or more gauges.

These drastic reductions produce very hard material. The austenitic chrome-nickels can be rolled to physicals well in excess of 150,000 lb. per square inch ultimate strength in sheet thickness, and the power of the mill to move such material far exceeds that used in ordinary cold rolling. Bearing capacity and mill design indicate about 50,000 lb. load per inch of face, a 50in. sheet requiring mill capacity of 3,000,000 lb. at the bearings. The usual cycle of operations would be to give three or more passes to produce a reduction of 10 per cent. of the thickness, reanneal, and give one pass in ordinary rolls to flatten, roller level and stretch if a very flat sheet is desired. Remarkable surface can be produced by careful manipulation. Where exceptionally high finish is required, the hot mill finish of best quality is not satisfactory for simple cold rolling. The cold rolling operation is carried out as outlined above, the sheet is annealed soft, pickled, and the cold rolling repeated. This process is continued until the desired finish is obtained.

The high finish flat product stainless is also produced in cold rolled strip. This process is very desirable in the production of decorative materials. In such applications the maximum coverage for a given weight is important. With this is the requirement of very excellent surface, since practically all the material is polished. Various methods for cold reduction are being used. The conventional four high mill of ample capacity has demonstrated its ability to produce material in strips less than 0·010in. thick in the usual commercial widths. The tension cold rolling mills produce satisfactory material in all the commercial ranges. To date the writer has not been able to demonstrate that any metallurgical difference exists in the product by either process. In the tension rolling mill, a coil of hot rolled strip is started into the mill with no reduction, the end through the mill being clamped to a powerful reel. The main length of the coil is held on a similar reel on the opposite side of the mill. The pressure is applied to the rolls and the reel started pulling the coil through the mill. Since no power is required to drive the rolls, very small work rolls are possible. The reduction depends upon the stock and power of the unit, but can be quite heavy. When the coil nears the end the mill is stopped, the reel that has been nearly emptied is started and the strip reeled back. Thus, the strip is pulled back and forth, the rolls being adjusted each trip until the coil has been brought to the desired thickness. No intermediate anneal is used. The strip is reduced to nearly the desired finished thickness, annealed, pickled, and given a very light pass in a different mill to polish.

This method of rolling is very similar to that used to produce flat wires by the so-called Turks head process. It will be extremely useful where material less than 0·005in. is desired and is not limited to the rolling of steel; in fact, will probably find wider applications in the non-ferrous field.

An additional form of decorative stainless produced is polished material. Polished steel sheets, other than stainless, are uncommon. The staining of the surface would quickly destroy the finish of a polished sheet of simple steel. Polished plated sheets have been produced but no serious production of polished steel material has been available. The production of stainless in polished sheets is very large and is increasing steadily.

The usual type of metal polisher is a fabric wheel. The surface is sized with glue and abrasive grit is glued to this surface. The grades commonly used range from 60 to 180 mesh or finer. The usual finishing stage is about 120 grit. The modern polishing machine is an outgrowth of metal polishing done in plating plants, but the very large flat areas offer complications. A sheet 62in. by 160in. has been polished and larger sheets are feasible. In the author's mill a fabric roll about 18in. diameter and 72in. across the face is built up by pressing the fabric discs onto the shaft by hydraulic pressure. The discs are held under pressure by heavy washers that are screwed on the ends. After assembly, the discs are trimmed to line at a speed in excess of the final polishing speed to ensure even cutting surface. It is then sized with glue and the glue cured. It is given a coat of the proper grade of abrasive in glue and again cured. It is returned to the trimming machine and the face trimmed to alignment with a diamond dresser. It is then given a second coat of abrasive, cured, trimmed, and is ready for work.

To grind it is mounted in an oscillating head machine, in roller bearings, and driven at proper speed. The sheet, mounted on a traversing table below the grinding roll, is entered over a roll and passes between the grinding roll and a supporting roller. The sheet being ground is supported above the supporting roller by another sheet and a cushion of composition board. The grinding roll is brought into contact with the sheet by pressure, which is adjusted by carrying the supporting roller on an air cylinder. When the surface is properly prepared the sheet is removed to a similar machine using a finer grit. The operation proceeds by stages until the desired finish is obtained.

The usual finishing operation is on a belt grinding machine, using a canvas belt to which has been glued abrasive of the proper size. This gives a very even texture to the finish. The sheet is then cleaned of the grease used during the grinding operations by wiping, inspected to make certain the finish is proper and sheared to size.

Various finishes are produced from a ground stock to very high polish. The usual commercial finish is on a belt using 120 grit abrasive with grease. The higher finishes may involve three to five stages in addition, the last being a buffing operation. Where a dull surface is desired, a Tampico fibre brush is used to produce the proper finish. The final product is packed with paper to protect the usual finish, while the high finishes are packed in cloth to ensure protection of the surfaces. Polished stainless sheets are far from the usual product produced in a steel mill.

### Applied Surfaces.

For some applications only a stainless surface is required, and stainless covered surfaces are being produced at this time. Two methods have been used. An ingot having a stainless surface is poured and is rolled to the final product. This method is not commercially successful, because the stainless outside is quite heavy. A modification of the ingot method is to pour simple steel about stainless slabs, this giving a composite ingot with the stainless slabs in the centre. The ingot is rolled to a slab or plate, the edges sheared off, and the whole separated into two plates. The further reductions are made on the single plates, the stainless sides of the plates being faced together during rolling. This type of material is better in fairly heavy gauges where the stainless is not so liable to cause curved plates. The other method is to make a composite pack using simple steel and covering with stainless. The edges are welded to prevent furnace gases from entering between the sheets and oxidising the surfaces. The whole is heated to a fairly high temperature, but far below the usual welding temperature, and the pack rolled. If the surfaces have been pickled properly, the whole welds very readily. The pack, after welding, is rolled to the desired gauge. The finish, drawing

* From a paper by E. C. Smith, of the Republic Steel Corporation, Massillon, Ohio, read before the American Iron and Steel Institute, at New York, May 19th, 1932.

† No. I. appeared June 17th.

qualities, and general workability are satisfactory, and further development of this process may be expected.

FUTURE OF "STAINLESS."

In the future relations of stainless to the general industry any prediction is but a guess. Until it has been definitely established what property or combination of property is essential for each of the conditions encountered, many misapplications will be made. The present production shows three fields in which the product is established—heat-resisting materials, food handling and decorative material. The present production of decorative material is important and is increasing. It will tend toward strip in the future. Food handling is important, both from the appearance and the general satisfaction given by the product. The field that has appeared to hold very great possibilities is the heat-resisting field. The ability of these highly alloyed steels to withstand scaling and corrosion and to retain physical properties at elevated temperature is unique in the metallic products field. The decorative products and food handling materials are subject to direct competition, but stainless steels stand alone in the field of metallic refractories. Not only are these materials useful in direct flame, but they have opened up new design possibilities due to their ability to handle heavy loads at temperatures much higher than possible with simple steels. The entire power generation equipment of the modern plant will eventually be constructed of such materials or their modifications. The oil refining industry is a large customer at present and will consume more as the problems are cleared. The name stainless is, and will be, a doubtful way to distinguish this useful group of materials.

The near future does not promise any great reduction in the cost of these products. Sufficient chromium to produce desirable properties would make cheap material out of the question regardless of carbon content. For this reason it seems unwise to predict many thousands of tons of this material annually for some period of time. The production problems are a factor at present. It will increase rapidly with better business conditions, but is, and will remain, a special product for some time to come. It will be much easier to work with skilled crews trained to handle special materials in small lots. It seems a very far day when any single mill will produce only such material. The extreme variety of products possible from any one type of analysis would indicate a breadth of application beyond the possibility of a single mill to produce. If all the variations of type be included, the result is truly amazing. For this reason the product will gradually be produced in all the plants equipped to make special steels. This means that for some time it will be the product of tool steel mills. The large production plants will produce the flat products in a large way. The bar products will continue as tool steels for some time. The wire and special shapes will develop slowly. The production will be scattered widely, many plants furnishing small amounts and specialising on the production of a limited number of products. With time will come the mill provided with a full line of equipment to specialise in this commodity. Such a mill will be an organisation of men trained to understand the production of this metal which comes more closely to the ideal commercial metal than any so far developed. They will be steel men, theirs will be a product worthy of the most skillful, a production metal, a steel that will endure with time.

## A FERRANTI EXHIBITION.

IN celebration of its fiftieth year of existence the Ferranti Company, which began operations as Ferranti, Thomson and Ince on September 15th, 1882, and which has rendered so much valuable assistance in the development of electrical engineering, has opened for a period of two weeks an interesting exhibition of some of its products at Bush House, Strand. The early work of the company is known to electrical engineers throughout the world, and its importance is universally appreciated. Under the guidance of the late Dr. Ferranti the firm grappled with many problems and succeeded in producing all the electrical equipment for generating stations. Alternators, transformers, rectifiers, switchgear, and even engines were manufactured in the Ferranti works, which are still busily engaged on the production of electrical goods. Although the company has, of course, long discontinued the building of generating sets, switchgear, and rectifiers, it has extended its activities into other important fields which should provide good business in the future. Domestic electrical equipment, for example, such as water heaters and fires, are among the exhibits at Bush House. Needless to say, there is a good display of the Ferranti wireless products, by which the firm is perhaps best known to the general public. A new seven-valve super-heterodyne receiver is claimed to be the finest instrument that has been put upon the market at the price asked for it. Among the wireless components are audio-frequency and mains transformers, chokes, battery eliminators, and loud speakers.

Another popular demand the firm has set out to meet is that for synchronous electric clocks, which are made with Bakelite, wood, and metal cases. Besides the clocks themselves, the working mechanisms are separately displayed and serve to show that in an electric clock there is little to get out of order.

Some of the earliest models of Ferranti meters exhibited have only recently been taken out of service. There are also modern meters, including prepayment, polyphase, two rate meters, A.C. and D.C. switchboard meters, and a rotating testing meter set with meters being tested under working conditions. Meter manufacturing machinery on view includes pivot hardening and burnishing machines, a micrometer jewel examiner, and other apparatus associated with the work. The indicating instruments shown, which range from 2½in. to 10in. dial instruments, are extremely well finished and very dead beat. There is also a panel showing the grid metering system as adopted by the Central Electricity Board.

Although it was, of course, impossible for the firm to arrange for a display of large transformers as manufactured for the "grid," the transformer department is well represented. Among other things there is a 132-kV oil-filled condenser bushing, one of the "on-load" tap-changing switches, as fitted to the Ferranti "grid" transformers, Bakelite tubes, safe load indicators, a mercury switch voltage regulator, as described in our issue of February 12th, 1932, an X-ray transformer, and an example of the smallest Ferranti transformer made.

Readers of THE ENGINEER have been kept pretty well in touch with the transformer and other developments at the Hollinwood works. Since the firm installed its first "on-load" tap-changing transformers at Bow we have dealt with other and larger Ferranti transformers similarly equipped with the firm's parallel winding and choke coil methods of tap changing. This is the only firm in this country that adopts the two schemes; all the other transformer makers employing the choke coil method exclusively. It is, we believe, also the only firm which produces surge absorbers, which are to be seen at the exhibition, together with a small surge generator for demonstrating how an absorber reduces the destructive power of a surge. The scheme was described in our issue of July 13th, 1928, but the surge generator at Bush House is little more than a model as compared with the large equipment for testing full size apparatus at the Hollinwood works. Just as the firm did great things in bygone days, so is it keeping pace with modern requirements and producing goods of service to the supply industry and consumer alike.

# Provincial Letters.

## THE MIDLANDS AND STAFFORDSHIRE.

*(From our own Correspondent.)*

### Conditions Unchanged.

THE industrial situation in the Midlands and Staffordshire shows no change again this week. Activity is limited and about on a par with other weeks this month, while demand for iron and steel is also at recent levels. There are certainly more inquiries about, however, and prospects are brighter than they have been at any time this year. The market tone at Birmingham has improved, and anticipation of a revival in trade in the near future has renewed interest. Producers of iron and steel await the Midsummer Quarterly Meeting of the Midland Iron trade, which they hope will provide some tangible evidence of trade improvement and also give them an idea of the probable business movement to be expected during the next three months.

### Bilston Furnaces.

Outstanding activity in this area is in progress at the Spring Vale furnaces at Bilston, Staffs., where most departments are at date very busy supplying the needs of allied firms. The full plant is not, of course, in operation, but regular work is found for the plant in commission, which cannot be said for the majority of works in the heavy industries of South Staffordshire. Recently a new blast-furnace was blown in, and this appears to have created some misconception as to the industrial position of the district. The fact is that the new furnace is to take the place of one which will go out of commission very shortly, as two permanent furnaces can supply the needs of the moment.

### Reorganisation.

Mr. C. E. Lloyd, chairman of N. Hingley and Sons, Ltd., Netherton Ironworks, Dudley, is the elected chairman of the Wrought Iron Industry Special Committee, one of the bodies of producers taking part in the reorganisation of the iron and steel producing industry. Mr. Lloyd has been chairman of Hingley's since 1918, and is a director of the Great Western Railway and Lloyds Bank and other companies. The national Committee has received an important access of strength in the acceptance by Sir W. Charles Wright of the invitation made to serve on it. Sir Charles Wright is chairman of Baldwins, Ltd.

### Tube Investments Acquisition.

A meeting of Tube Investments was held on the 22nd inst. to sanction an increase in the capital for the purpose of taking over the shares of Stella Conduit Company, of Bradley, Bilston, Staffs. The capital is to be increased to £3,000,268 by the creation of 18,000 7 per cent. "B" preference shares, and 9000 ordinary shares, all of £1 each. It is interesting to note that companies of which Tube Investments already hold the shares are: Accles and Pollock, Credenda Conduits, Simplex Conduits, Tubes Ltd., J. A. Phillips and Co., Bromford Tube, Midland Tube, Tube Products, Reynolds' Tube, and several others. The works of many of these firms are in the Birmingham and Black Country area. As is well known, the company has liaison agreement with Stewarts and Lloyds Ltd.

### Guest, Keen and Nettlefolds' Report.

The report of Guest, Keen and Nettlefolds, Ltd., for the year ended March last, shows a net balance of £201,569, but no dividend is to be paid on either the second preference of ordinary share capital. The company is raising the balance to be carried forward from £347,489 to £450,058, the directors considering it wise to conserve the resources of the company in every possible way. While the new fiscal policy of the country is welcomed by the board, the change, of course, did not come in time to affect the results during the year under review. Although the directors refrain from making any comment on the prospects for the current year, it can at least be said that the protection now afforded to the heavy industries by the new tariff duties places the company in a somewhat better position.

### General Electric Profits.

The General Electric Company, Ltd., made a profit on the past year of £1,057,657. Although this result shows a decrease of £64,350 compared with the profits for the previous year, the directors state that they consider it very satisfactory, having regard to the abnormal conditions prevailing throughout the year. Instead of recommending a 10 per cent. dividend, as last year, when the carry forward was £400,880, the directors this year are proposing a dividend of 8 per cent. with a carry forward of £420,135. The directors have allocated £130,000 to reserve account, which now stands at a total of £1,420,000.

### Improved Motor Trade.

The improved and agreeable weather of recent date is proving welcome and helpful to automobile engineers in the Birmingham, Coventry and Wolverhampton areas. Sales, especially of light cars, are said to have gone up already, and there is every prospect of the selling period being lengthened this year. Activity at the works is maintained at a good level; indeed, there is little or no evidence of slackening off at any of the principal factories. Encouraging reports from overseas markets have added to the satisfaction and have helped to bring about the cheerful tone now prevalent in this class of engineering hereabouts. Midland cars continue to enhance their reputation overseas, and are becoming firmly established in markets where formerly American products held sway. It is reported on good authority that a number of firms in this district have greatly extended their business in the South African markets this year.

### Structural Engineers at Gloucester.

The summer meeting of the Western Counties Branch of the Institution of Structural Engineers was held during last week-end at Gloucester. It attracted structural engineers from the West, the Midlands and South Wales. The visitors were welcomed by the Cty High Sheriff (Councillor Wallace Harris) and Alderman S. J. Gillet, and later visited the Cathedral. The City High Sheriff, addressing the branch, said structural engineers were being called in by architects to-day, but the time was not far distant when the structural engineers would call in the architects. Major E. C. P. Monson, President, thanked the City High Sheriff for his welcome.

### Steel.

The steel trade in this area is slightly brighter, there having been an improved call for special steels which is likely to be maintained. Unfortunately, structural steel business continues scarce, most of the Midland engineering firms being short of large contracts. They continue to secure small works, but often these involve only a few tons of material. Association basis prices are quoted on all occasions. Angles are £8 7s. 6d., less 15s. rebate to users confining themselves to British steel; tees, £9 7s. 6d., less 15s.; joists, £8 5s., less 22s. 6d.; ship, bridge and tank plates, £8 17s. 6d., less 15s. Boiler plates sell at £8 7s. 6d. to £8 10s. In the half-products department business is quiet, there being large holdings of Continental semis at the works. Neither native or foreign producers are receiving much support at the moment, but the outlook for the former is more hopeful. Re-rollers in the Staffordshire area ask £6 7s. 6d. for small re-rolled bars, and £7 upwards for all-British bars. Mild steel billets vary from £4 17s. 6d. to £5 7s. 6d., and sheet bars from £5 to £5 5s. Staffordshire hoops are held for £9 10s. There are very few inquiries for steel scrap and prices are on a low scale.

### Manufactured Iron.

In the Staffordshire finished iron trade there is no change from recent prevailing conditions. Consuming foundries in this district are operating on a restricted basis and they are cautious about entering into forward commitments. The heavy engineering foundries are unable to report improving outlook, but makers of light castings anticipate increased activity in the near future. Makers of best grade Staffordshire bars hold their selling price at £12 per ton at makers' works, and although there is no diminution of the competition for business in Crown quality iron values have not sunk lower. They range from £9 upwards. Producers of nut and bolt and fencing bars expect to benefit from tariffs when consumers' existing stocks need replenishing. They will need to wait some time, however, at the present rate of consumption before this can come about, as stocks at the works are large. This class of bar is quoted £7 15s. to £8 per ton delivered. Wrought iton tube strip sells moderately well at £10 10s., and mills have a fair amount of work on hand.

### Raw Iron.

In the Midland pig iron industry blast-furnacemen complain of the scarcity of specifications and the difficulty of inducing consumers to make new contracts for foundry iron. Production is maintained at recent levels, though some material, especially of Northamptonshire make, is going into stock. Values are upheld at the figures fixed by the Central Pig Iron Producers' Association, namely, £3 2s. 6d. for Derbyshire No. 3 foundry, £3 1s. for forge, £3 2s. 6d. for Northamptonshire No. 3 foundry, and £2 17s. 6d. for forge, all per ton delivered to stations in the Black Country zone. It is thought that the associated makers, when they review the position at the end of the month, will again reaffirm existing prices, there having been no radical change in the position of the industry during the current month.

### Sheets and Plates.

The minimum selling figure for 24-gauge galvanised corrugated sheets is held at £9 5s., though many local mills are badly in need of orders. Some makers are getting much better prices and, indeed, they refuse to enter into the competition for business at what they consider unremunerative prices. The demand from home consumers keeps up, but export buying continues on a small scale. The call for lighter gauge sheets is also quiet. Black sheets are in better request and selling rates are unchanged. A little more inquiry for tin-plates is reported. Stocks in second-hands have been depleted, and quotations are now 14s. 6d. to 14s. 9d.

## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER.

### New Enterprises.

IT is satisfactory in these days to be able to record the launching of new industrial enterprises. An interesting Lancashire development of this nature is the formation of a private limited company under the title of British Copper Refiners, Ltd., which is closely associated with British Insulated Cables, Ltd., of Prescot. The new company will be concerned chiefly with the importation of Rhodesian blister copper and the production of high-conductivity copper for electrical purposes, the capacity of the plant being estimated eventually to reach about 1000 tons of refined copper a week. Productive operations on a small scale have been started. Another development announced this week concerns the manufacture of fire-brick and furnace arch cement by an American company, whose decision to establish a plant at Broadheath, near Manchester, on the Bridgewater Canal, has been reported by the Manchester Development Committee. The necessary machinery for the purpose is in process of being installed, and it is expected that actual production will begin at a comparatively early date.

### Engines and Boilers for the East.

The receipt of an order for very large engines for China and of orders for boilers for India, which will keep the works fairly busy during the current year, are referred to in the annual report of Nasmyth, Wilson and Co., Ltd., locomotive and general engineers and ironfounders, of Patricroft, near Manchester. The report covers the period to the end of December last, a year which proved to be anything but satisfactory. Never before in the history of the locomotive engineering industry, it is pointed out, was depression so severe as it was in 1931, and the number of orders received by the Company was less than in any other year since it began business nearly ninety years ago, the falling off being ascribed to general depression in all or most industries in all parts of the world, and to the severe competition from road transport. During the past year, the report states, less than 5 per cent. of the capacity of the locomotive works of the company was employed. The year's operations of Nasmyth, Wilson and Co., resulted in a loss of £14,232, compared with a loss of £11,255 in 1930, the preference dividend only, as in the previous year, being paid.

### Industrial Results.

The debit balance at the profit and loss account of the Broughton Copper Company, Ltd., Manchester, is increased to £75,716 in consequence of the loss sustained on the company's operations during the year to March 31st last of £48,107, the latter figure comparing with a loss of £35,608 in the previous twelve months. The preference dividend is in arrears as from October, 1929. Although the loss is greater than that of 1930–31, the report states that actual trading showed a considerable improvement, special provision having been made for depreciation, obsolescence, and stock adjustments. The profit of Hick, Hargreaves and Co., Ltd., of Soho Ironworks, Bolton, was reduced in the year ended March 31st to £580 from £6207 in 1930–31, no distribution being made to the ordinary shareholders, against 2 per cent. in the previous year.

### Electrical Engineering at Manchester University.

Manchester Education Committee has decided to advertise for a successor, at a salary of £1200 a year, to Dr. Miles Walker, who in August next retires on superannuation from the Chair of Electrical Engineering at Manchester University and at the Manchester College of Technology.

### Obituary.

The death has occurred at the age of eighty-four years, of Mr. John George Hudson, of Bromley Cross, near Bolton. For about forty years Mr. Hudson was associated with Hick, Hargreaves and Co., Ltd., of Soho Ironworks, Bolton. For twenty-eight years he was a director of the company, and for a number of years the chief engineer.

### Non-ferrous Metals.

The non-ferrous metals market has finished up on a somewhat steadier note, and minor gains have occurred on balance in all sections. Up to the present there has been little improvement in the demand for tin, either from home or Continental users of the metal, but "bearish" influences in this market have been offset to some extent by a slight decline in stocks held in this country, and expectations of an early announcement on the question of a further restriction of output. A net advance on the week of about 10s. per ton has resulted after ups and downs, which, however, have been within a relatively small compass. A certain amount of firmness has been induced in the copper section by speculative support of the market, but the demand from users remains slow. At the moment of writing, standard brands are dearer by from 7s. 6d. to 10s. per ton, with a corresponding rise in refined descriptions. A new low price record was touched by lead during the week, but on speculative support and in sympathy with other sections there was a recovery, and values show a net gain of approximately 5s. per ton. The steadier tone extended also to spelter, and an advance in prices of several shillings a ton has occurred.

### Iron and Steel.

New business in the Lancashire foundry iron markets is of moderate dimensions only, and reports are general as to the restrictive influence of the heavy supplies of machinery scrap, both on fresh orders for pig iron and on deliveries into consumption. Offers of good machinery scrap in Lancashire are at a top price of about 40s. per ton delivered, although as low as 30s. has been mentioned in some quarters during the last few days. The result has been a steadily growing consumption of scrap to the detriment of foundry iron. Quotations for the latter are maintained at 67s. per ton, delivered to Manchester users, for Staffordshire, Derbyshire, and North-East Coast No. 3, with Northamptonshire at 65s. 6d., Derbyshire forge iron at 62s., and Scottish No. 3 at 86s. to 87s. per ton. A few small orders for finished iron have been reported. Prices keep steady at £10 5s. per ton for Lancashire best bars, and £9 15s. for Crown bars. The demand for virtually all descriptions of steel proceeds on quiet lines, with little or no change in the general price position. Acid and basic quality boiler plates are at about £8 12s. 6d. per ton, small re-rolled bars at £6 15s. to £7, sections at £8 7s. 6d., joists at £8 15s., ship and tank plates at £8 17s. 6d., and large-diameter bars at £9 7s. 6d. A quiet trade is reported in Continental products at about the following prices for delivery in the Manchester district, including duty:—Siemens plates, £6 5s. per ton; Thomas plates, £5 12s. 6d.; wire rods, from £6 15s. to £6 17s. 6d.; joists, at £5 2s. 6d.; angles, at £5 5s.; billets and sheet bars, at £4 5s.; and Belgian iron, at about £6.

BARROW-IN-FURNESS.

### Hematite.

The condition of the hematite pig iron market continues to be quiet, and the output at present is quite able to cope with the demand, apart from stocks, which still exist in fairly large quantities in the district, including those at works at present idle. At Barrow the steel departments are taking a large proportion of the iron produced. There has been no upward tendency noticeable as yet, and buyers are still ordering for immediate requirements only. There is still no tendency to place orders for forward delivery. Business with the Continent and America continues to be dull. Evidently, overseas requirements are still very light. The native ore trade is quiet, and will continue to be so until there is a general improvement in trade requiring increase of iron output. Business with outside iron producers continues to be thin. Foreign ores are in restricted demand. The steel market continues to be quiet. The rail mills at Barrow remain engaged, but fresh orders would be welcome. Fuel is in steady demand, but on the quiet side.

## SHEFFIELD.

*(From our own Correspondent.)*

### Hopes of Better Trade.

AN interesting feature of the present position of the local steel industry is that some of the smaller works which had long periods of bad trade, but improved at the end of last year, are now maintaining that improved activity. Another matter for satisfaction is that although the demand for Sheffield steel for railway, shipbuilding, and engineering purposes continues poor, a considerable amount of work is being done for the motor industry, and there is a fair amount of activity in other special lines. So far as the heavy sections of the industry are concerned, it is felt that consumers have reduced their stocks to the minimum, and although business at present is confined to small orders in the majority of instances, an increased demand is expected in the near future. All these factors mentioned have given rise to a confident belief that there will be a revival of trade, probably in the autumn.

### Interesting Statistics.

Although exports of iron and steel materials last month declined to 151,325 tons from 180,436 tons during the previous month, it is possible to discover cause for local satisfaction, inasmuch as exports of special steels rose to 283 tons from 175 tons. These special steels, of expensive quality, are made almost exclusively in Sheffield. On the other hand, however, the figures for exports of railway materials provide an explanation of the comparative idleness of the departments of local works which are concerned with these particular manufactures. Over the last two years our once valuable trade in locomotive and rolling stock with foreign countries has fallen to negligible proportions. For the first five months of this year exports of locomotives amounted to £181,044, compared with £870,058 in the corresponding period of last year. Carriages have dropped from £733,510 to £152,635, and wagons from £618,631 to £180,000.

### At the Works.

Good reports are received of the activity of the United Steel Companies' plant at Ickles and Templeborough, where seven of the large steel furnaces are in commission and where there is corresponding activity in the mills and accompanying plant. It is announced that Hadfields, Ltd., of Sheffield, have acquired the manufacturing and selling rights of Taylor's patent three-stage coal-breakers, which are made in several types. Specially toughened steel and manganese steel are used for the parts of the breakers that bear the hardest work.

### Stainless Steel Bands.

Reinforcements consisting of a series of stainless steel bands for the masonry of the Church of the Holy Sepulchre of Jerusalem, have just been completed and dispatched by Brown Bayley's Steel Works, Ltd. The largest of the bands will pass round the drum at the base of the dome and has a circumference of 120ft. The other four bands will be tied into the masonry of the dome itself. The firm was entrusted with the work by the Crown Agents for the Colonies, and the inspection of the five completed bands by the Inspector for the Agents lasted a week, but revealed that the construction had been carried out with the utmost exactitude. Sheffield has also previously undertaken reinforcement work of importance, notably that of the dome and peristyle of St. Paul's Cathedral.

### By-products Works.

At the works of the Staveley Coal and Iron Company, Ltd., near Chesterfield, there is in course of construction plant for making bleach powder, which will have a capacity of 20 tons per day. These extensive and up-to-date by-products works include plant for the recovery of tar—1000 tons per week being dealt with—benzole, &c., and other plants are for sulphuric acid, oleum, nitric acid, aniline and soda. The four blast-furnaces turn out 4400 tons of pig iron per week and a weekly output of 5000 tons of slag is made into road material. Electricity is generated from waste gas, which operates three large gas engines ranging from 7150 to 5000 horse-power, and of the current generated 75 per cent. is used on the works, the remainder being sold to outside users.

### Gas Grid Scheme.

The Sheffield Gas Company, which is to own and control England's only gas grid, has obtained authority to raise £400,000 towards financing it. Having regard to the magnitude of the scheme and the prevailing trade depression, it has been considered advisable to carry out the work by sections rather than as a whole. The laying of the main which comprises one of the sections has already been begun, and this will be followed by the acquisition of the necessary plant and equipment, together with storage accommodation.

### Modern Mining.

Members of the Institution of Mining Engineers, during their stay in Sheffield for their annual Conference, visited the Nunnery Colliery Company, Ltd., at whose pits modern improvements in mining are in operation. A large part of the output is undercut by electric or compressed air-driven machines, and is taken out of the districts by mechanically operated conveyors, a novel form of which, called scraper loading, requires practically no effort on the part of the workman, apart from breaking down the coal, in which he is assisted by electrically drilled shot holes fired with compressed gas. The whole face is lighted by means of oridnary electric bulbs supplied with current from the mains, instead of the usual miner's hand lamp. The coals are taken to washeries and a dry-cleaning plant of novel construction.

### Wire Rope Feat.

The Sheffield Wire Rope Company, Ltd., Darnall, Sheffield, is said to own the largest wire rope-making machine in the district. On this machine has been made a wire rope ¾in. in diameter, weighing 31 tons and measuring 11¼ miles in one continuous piece without a splice. The rope was made of Sheffield steel.

### Cutlery and Tools.

Although the cutlery trade is showing few signs of improvement, manufacturers of implements and tools, particularly precision tools, are doing fairly well. The position is shown by the facts that exports of implements and tools increased again last month and during the first five months of this year the total exports, amounting to £733,684, showed an increase of nearly £50,000 upon the same period of last year. During the same period imports of these goods have been only a quarter of those recorded last year.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Cleveland Iron Trade.

WHILE actual transactions in Cleveland pig iron are still confined to narrow limits, some slight expansion of inquiry is reported and the general tone of the market has slightly improved. It would appear that time is needed for any impetus to develop from the new import duties. Nevertheless, makers face the future in a hopeful frame of mind. They still continue to retain a share of the small distribution of orders by firms in Scotland, but are only able to do so by accepting specially low rates. To home consumers prices are steady, No. 1 Cleveland foundry iron being 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

### East Coast Hematite.

Buyers of East Coast hematite pig iron are apparently realising that there is nothing to be gained by holding up orders, and are a little more in evidence. They claim to be still able to cover requirements at the equivalent of ordinary qualities at 62s. 6d., but while there are merchants who do not refuse such terms, makers are now asking 6d. more. No. 1 quality is at a premium of 6d. per ton.

### Manufactured Iron and Steel.

Most of the manufactured iron and steel works are still working irregularly. Orders are more numerous, but they are mostly for small tonnages, and it is volume that is needed. Progressive improvement is expected in the autumn, but in the meantime trade is dull and prices are unchanged.

### Ironmaking Materials.

There is next to no demand for foreign ore, and best Rubio is nominal at 15s. c.i.f. Tees. Consumers of blast-furnace coke have still ample supplies of their own makes and are not obliged to come on to the market, with the result that transactions are few and small. Sellers are anxious to liquidate stocks, but are markedly disinclined to accept below the basis of Durham good average qualities at 15s. 6d. delivered at the works.

### The Coal Trade.

The Tyneside holiday interlude this week has manifested itself on the coal market, and business has been curtailed to some extent. The annual race week,

however, is not a holiday with the collieries, for the great majority of them work as usual if they have orders. Only a few pits in the Newcastle area have been idle a couple of days. This year there has been less desire than ever to take a day off because of so much enforced lost time on account of the quietness in trade. Taking a broad survey of the coal industry in Northumberland since the year began, however, the county has had much to be thankful for, as it is doubtless true to say that no district has done any better—if as well. Northumberland has got its share of the business going, and has not been so hard hit as Durham, which has more classes of coal to sell and the demand for some of these is very quiet. At the moment eyes are directed to the Lausanne Conference. If the outcome is favourable it is believed that there will be a stimulus for the coal trade. For the next five years the system of quotas of production and minimum prices under the district marketing schemes, first introduced under the Coal Mines Act of 1930, will be continued. The working hours remain unchanged at 7½ a shift, but wages are to continue at the current level for twelve months, after which they may be reviewed. There are no signs that the range of prices in the counties of Northumberland and Durham will undergo any alteration, but, on the other hand, the symptoms are that this part of the selling machinery will be kept as it is at the present time, however eager exporters may be for greater elasticity in the figures at which coal may be bought. There is a sharp difference of opinion on this question. The exporters, very naturally, desire the largest measure of freedom in which to secure foreign trade, while the coalowners' view in the main seems to be not only to maintain minimum prices at as high a level as possible, but to tighten up the selling conditions so effectively as to check anything in the nature of evasion of minimum prices.

**Market Conditions.**

The coal market has entered upon its quietest period of the year, but it is encouraging to note that there are still a number of inquiries circulating for supplies over the next six months. Northumberland steam coal is moving off at about the recent average, which, of course, is much below the volume of trade in the earlier months of the present year. Current demand is of moderate dimensions, but production has to be cut down at all pits very severely, the present available supply being just about equal to requirements. Prices are, therefore, unchanged, remaining nominally steady at the fixed minimum, with large at 13s. 6d., and small, owing to moderate output, at 8s. 6d. The major portion of the Swedish State Railway order for 180,000 tons of locomotive coal has gone to Poland, but 30,000 tons of the order has been placed for Northumberland qualities. Tyne prime large steams are unchanged at 12s. 9d., and small at 9s. Durham gas coal is offered in excess of requirements, and prices are quoted at an easy level. Best qualities are 14s. 6d., secondary 13s. to 13s. 6d., and coking coal, according to grade, 12s. to 13s. 9d. Best descriptions of unscreened bunker coal are in moderate demand, and sparingly offered at 13s. 6d. to 13s. 9d., with good seconds at 13s. to 13s. 3d. Stocks of gas coke are not excessive for this period of the year, and with a fairly good seasonal demand sellers ask steady prices. Best qualities are quoted at 17s. 9d. Patent oven coke stocks are abundant and offered at easy terms, good brands being 14s. and superior foundry makes 16s.

## SCOTLAND.

*(From our own Correspondent.)*

**Trade Outlook.**

On the whole, there is not much change in the position of trade so far as steel, iron, and coal are concerned. In certain directions, however, it may be said that the inquiries show a little more life, and business a slight increase, and although perhaps nothing of a very definite nature may happen before the holiday season, which begins in about three to four weeks' time. Producers are more hopeful that the autumn will witness a forward movement. Rumour has it that there are prospects of Admiralty work on the Clyde and the North-East Coast, which, if it materialises, will be especially welcome in the present state of the shipbuilding industry. Work on the Clyde at present mainly consists of reconditioning and repair work, a fair amount of which is in progress, but the immediate prospect at the yards is one of extended holidays.

**Improvements at Ayr Harbour.**

The L.M.S. Railway, which owns Ayr Harbour, is having three electrical coal conveyors erected there. The first has been given an official trial. This conveyor, erected on the east side of the dock, is designed to handle 600 tons of coal per hour, and is specially designed to minimise the breakage of coal. The conveyor is controlled by one operator who has a complete view of the loading arrangements. A second conveyor will be erected on the north side of the harbour, and a movable conveyor constructed at the dock. Complete electrification of the harbour plant is to be undertaken at a total estimated cost of about £100,000.

**Steel.**

The position in the heavy steel trade shows some improvement. The inquiry is fair, with a slight increase in turnover. The works, however, are still employed below capacity, and orders, especially for shipbuilding materials, would be greatly welcomed.

**Steel Sheets.**

Some sheet works are better off than others, but conditions generally are comparatively good. The volume of business with Canada is fairly satisfactory, and it is confidently anticipated that the shipments and the season will be considerably larger than for some years past.

**Steel Tubes.**

The tube works are having a spell of activity at present in anticipation of the revised tariffs which come into operation in Australia on September 1st. A number of orders are due for shipment this week-end, and it is understood that further consignments may be sent *viâ* London and other ports in time to arrive before the higher tariffs are in operation.

**Iron.**

Makers of bar iron and re-rolled steel bars do not make much progress. The tariffs in operation here are not sufficient to eliminate competition, and the business offered is restricted. Re-rolled steel bars are quoted £6 10s. home (fixed) and £6 7s. 6d. per ton export.

**Pig Iron.**

Scottish pig iron makers derive satisfaction from the tariff imposed on Continental iron, but have still to meet competition from Indian basic iron, considerable quantities of which have been coming over here for some time now. Six furnaces are in operation in Scotland, and supplies are ample.

**Coal.**

With household and general utility demands at their lowest level and industrial requirements below normal, the home market for coal is restricted and supplies are ample, despite a further curtailment of output. The export department also is quiet. Forward transactions are very limited, and business is mostly of a prompt nature for coastwise despatch. Foreign demands are limited by import quotas and duties, and also by keen Polish competition. Lanarkshire fuels are plentiful and the same applies to the Lothians. Best Fifeshire steams are scarce and treble nuts in the same district have a strong market, considerable quantities being shipped to Denmark. The allocation of the Swedish State Railways contracts have not been completed, but it is understood that the greater proportion will go to Poland. It is understood that Scottish fuel to the extent of 33,000 tons will be taken, 13,000 tons of which will be Lothian prime steams.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

**The Coal Trade.**

ANTHRACITE coals continue to display appreciably busier conditions than the steam coal section, and it is interesting to note that exports of the former during the month of May were better than during any monthly period of this year or 1931. This is perhaps the brightest feature of industry in South Wales at the present time, as tinplate, ship-repairing, and the iron and steel trades are without improvement. Steam coals may possibly be a shade better than of late, but it is only temporary, and so far as Monmouthshire qualities are concerned they are distinctly quiet. Figures of coal and coke shipments—that is, steam and anthracite—for the six ports under the control of the Great Western Railway Company were not quite as good last week as for the preceding week, but at the same time they cannot be accounted unsatisfactory. The total was 421,845 tons, as against 448,095 tons, while for the corresponding period of last year the quantity was 444,092 tons. Returns for this week may possibly show a recovery, for whereas at the end of last week the number of vacant loading berths was thirty-nine, the position on Monday was that the number was reduced to twenty-two, while on Tuesday the situation was even better, as the number of vacant loading berths was nineteen, and there were seven steamers waiting to load, of which three were at Swansea and three at Port Talbot. There has been a slight improvement in outward chartering of late, so that some collieries will be working better this week and possibly next, but it is impossible to look further ahead, or to be optimistic as to the prospects. There is growing evidence that the foreign inquiry is drying up, at least temporarily, and that orders are not coming along on a scale to make up for those which are now being worked off. Nothing fresh has developed with regard to contract operations of importance, while as to current inquiry, it is, as it has been, inadequate to absorb current production. The situation as regards supplies of coal for the Italian State Railways, to which reference was made last week, has not undergone any material change, except that news comes from Rome that the subject is being raised by the Italian Government at the Lausanne Conference. The Hague Agreement of 1929 stipulated for the purchase by the Italian Government of a million tons per annum for three years, but, as expected, the contention of the Italian authorities is that the agreement lapsed, owing to the cessation of reparation deliveries in kind, following the Hoover Moratorium.

**Coalfield Items.**

The special delegate conference at Cardiff called by the South Wales Miners' Federation Executive to consider the latter's report on recent negotiations concerning hours and wages, carried by 117 votes to 36 the resolution put forward by the Executive which meant the acceptance of the new Mines Act. This decision was fully expected, there being virtually no other course to adopt. The report of the Executive pointed out that, having regard to all the circumstances and the decision of the National Federation, any other action by South Wales alone would be quite futile at the present time. Reference has already been made to the unsatisfactory demand for Monmouthshire coals especially, and the fact that only a week or so ago the Powell Duffryn Company gave notices to a considerable number of workmen engaged at its pits. Since then the Tredegar Company has been compelled to adopt a similar course, owing to the lack of orders. At the end of last week this company had only one pit working and gave formal notice to over 4000 miners, but it was expected that rather more than 2000 of these notices would operate, and that the remainder of the men would continue on day-to-day contracts. Hopes are, of course, entertained that during this week and next, trade will improve so as to mitigate the position. Notices have also unfortunately been served on the workmen at one or two smaller collieries.

**Docks Traffic.**

Returns of the Great Western Railway of the seaborne traffic at its docks in this area for the four weeks ended the 5th inst. show that imports and exports came to 1,955,421, tons, as compared with 2,077,492 tons for the previous month, and with 2,237,900 tons for the corresponding period of last year. For the whole of this year to the 5th inst. the aggregate of imports and exports was 11,150,160 tons, which compares with 11,883,635 tons for the same period of 1931, so that the decrease amounts to 733,475 tons.

**Coal Tippers' Wages.**

Tippers at Newport, Barry, and Penarth recently agreed to the full reduction of 10 per cent. in the minimum wage rate in accordance with the National agreement concluded not long ago, but the Cardiff tippers opposed the maximum reduction. At a meeting on Tuesday, however, between representatives of the National Union of Railwaymen and the Great Western Railway Company, a compromise was reached, the Cardiff tippers agreeing to a reduction of 3s., equivalent to 5 per cent., thus making the minimum wage £2 17s. Tonnage rates are unaffected by this decision. No agreement has been come to at either Swansea or Port Talbot as regards the minimum wage rate, but meetings are to be held shortly for this purpose. With regard to the demand for a revision of the overtime tariff and certain anomalies at present existing concerning pitwood workers, it is announced that as the result of a meeting at the end of last week of representatives of the Cardiff and Bristol Channel Pitwood Importers' Association and the workmen, considerable progress was made, and that following further negotiations this week there is a prospect of agreement being come to.

**New Reservoir.**

Last week the Newport Town Council decided to accept the tender of Mr. J. McColville, of Abergavenny, for the construction of the Talybont reservoir at £367,699, subject to approval of the Unemployment Grants Committee.

**Steel Works Restart.**

The Whitford Steel and Sheet Galvanising Works at Briton Ferry resumed operations on Monday after a considerable period of inactivity. This will mean employment for about 400 men.

**Current Business.**

Generally speaking, there has not been much change in the market for steam coals. The position of individual concerns has varied, but so far as most descriptions of coals are concerned, there has not been sufficient demand to absorb existing production. Dry coals are an exception, and are very steady, sellers being able to secure a premium on schedule minimum prices in some instances, but other large and small coals are excessive. Coke is a very limited market, but patent fuel is well stemmed for the next fortnight. Pitwood remains without material change at 19s. to 20s. 6d.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. G. A. R. MEAD has been elected a member of the board of the Skefko Ball Bearing Company, Ltd., in the capacity of sales director.

THE "VISCO" ENGINEERING COMPANY, Ltd., has removed its works and offices to Stafford-road, Croydon, Surrey. Telephone, Fairfield 4181/2/3; telegrams, "Curtmit, Croydon."

MR. ERNEST A. SMITH, A.R.S.M., M. Inst. M., has been appointed to the technical staff of Oakes, Turner and Co., Ltd., of Sheffield, the affiliated northern house of Johnson, Matthey and Co., Ltd., precious metal refiners.

MR. FRANK G. WOOLLARD, late director of Morris Motors, Ltd., and general manager of the engine branch of that company at Coventry, has joined the board of Rudge-Whitworth, Ltd., and has been appointed assistant managing director.

MR. G. L. KIRKPATRICK, M.I.E.E., has been appointed general manager of Bruce Peebles and Co., Ltd., electrical engineers, East Pilton, Edinburgh. MR. Kirkpatrick has resigned his position as a member of the directorate and the staff of Asea Electric, Ltd., 5, Chancery-lane, W.C. 2. Mr. C. J. Hunt, chief engineer, has been appointed assistant manager of Bruce Peebles and Co., Ltd.

## CATALOGUES.

METROPOLITAN-VICKERS ELECTRICAL COMAPNY, Ltd., Trafford Park, Manchester.—Leaflet No. 341/42–1, dealing with balanced beam relays and line drop compensator.

FOSTER INSTRUMENT COMPANY, Ltd., Letchworth, Herts.—An 88-page book on thermo-electric pyrometers, which includes a section explaining the principles of thermo-electric pyrometry

MARKHAM AND CO., Ltd., Chesterfield.—An album of illustrations of the various works carried out by the firm, including winding engines, pumping engines, rolling mill engines, complete blast-furnaces, excavating shields, capstans, &c.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—On Wednesday evening, June 22nd, a conversazione of overseas members was held at the Institution of Electrical Engineers' headquarters, Savoy-place, Victoria Embankment. At 8.30 p.m. there was a reception by the President and Council and was followed by short addresses in the lecture theatre. The lecturers were Sir Archibald Page, Sir Thomas F. Purves, and Mr. N. Ashbridge, who dealt with "The Grid," "Transatlantic Telephony," and "Broadcasting To-day" respectively. Following these addresses there was a reunion in the library, where refreshments were served and where original manuscripts of famous electrical people and rare books were inspected. The gathering, which was arranged with a view to bringing overseas members at present in this country together, proved highly successful, and reflected great credit on the organisers.

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| N.W. COAST— | |
| (1) Native | 16/6 to 20/– |
| (1) Spanish | 17/– to 22/6 |
| N.E. COAST— | |
| Native | 18/– to 21/– |
| Foreign (c.i.f.) | 15/– |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) SCOTLAND— | | |
| Hematite | 3 8 6 | — |
| No. 1 Foundry | 3 12 0 | — |
| No. 3 Foundry | 3 9 6 | — |
| N.E. COAST— | | |
| Hematite Mixed Nos. | 3 2 6 | 3 2 6 |
| No. 1 | 3 3 0 | 3 3 0 |
| Cleveland— | | |
| No. 1 | 3 1 0 | 3 1 0 |
| Siliceous Iron | 3 1 0 | 3 1 0 |
| No. 3 G.M.B. | 2 18 6 | 2 18 6 |
| No. 4 Foundry | 2 17 6 | 2 17 6 |
| No. 4 Forge | 2 17 0 | 2 17 0 |
| Mottled | 2 16 6 | 2 16 6 |
| White | 2 16 6 | 2 16 6 |
| MIDLANDS— | | |
| (c) Staffs.— | (*Delivered to Station*). | |
| All-mine (Cold Blast) | — | — |
| North Staffs. Forge | 3 1 0 | — |
| „ „ Foundry | 3 6 0 | — |
| (c) Northampton— | | |
| Foundry No. 3 | 3 2 6 | — |
| Forge | 2 17 6 | — |
| (c) Derbyshire— | | |
| No. 3 Foundry | 3 6 0 | — |
| Forge | 3 1 0 | — |
| (3) Lincolnshire— | | |
| No. 3 Foundry | — | — |
| No. 4 Forge | — | — |
| Basic | — | — |
| (4) N.W. COAST— | | |
| N. Lancs. and Cum.— | | |
| Hematite Mixed Nos. | 3 15 6 (*a*), 4 0 6 (*b*), 4 5 6 (*c*) | — |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND— | | |
| Crown Bars | 9 15 0 | 9 5 0 |
| Best | — | — |
| N.E. COAST— | | |
| Iron Rivets | 11 5 0 | — |
| Common Bars | 9 5 0 | — |
| Best Bars | 10 5 0 | — |
| Double Best Bars | 10 15 0 | — |
| Treble Best Bars | 11 5 0 | — |
| LANCS.— | | |
| Crown Bars | 9 15 0 | — |
| Second Quality Bars | 8 5 0 | — |
| Hoops | 12 0 0 | — |
| S. YORKS.— | | |
| Crown Bars | 9 15 0 | — |
| Best Bars | 10 15 0 | — |
| Hoops | 12 0 0 | — |
| MIDLANDS— | | |
| Crown Bars | 9 0 0 to 9 15 0 | — |
| Marked Bars (Staffs.) | 12 0 0 | — |
| Nut and Bolt Bars | 8 0 0 to 8 10 0 | — |
| Gas Tube Strip | 10 10 0 | — |

## STEEL. (*d*)

| | (6) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) SCOTLAND— | | |
| Boiler Plates (Marine) | 9 0 0 | 8 10 0 |
| „ „ (Land) | — | — |
| Ship Plates, ¾in. and up | 8 15 0 | 7 15 0 |
| Sections | 8 7 6 | 7 7 6 |
| Steel Sheets, ¼in. | 7 15 0 | 7 15 0 |
| Sheets (Gal. Cor. 24 B.G.) | 11 15 0 | 11 0 0 |

## STEEL (*continued*).

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| N.E. COAST— | | |
| Ship Plates | 8 15 0 | 7 15 0 |
| Angles | 8 7 6 | 7 7 6 |
| Boiler Plates (Marine) | 10 10 0 | — |
| „ „ (Land) | 10 0 0 | — |
| Joists | 8 15 0 | 7 7 6 |
| Heavy Rails | 8 10 0 | — |
| Fish-plates | 12 0 0 | — |
| Channels | 10 5 0 | £9 to £9 5s. |
| Hard Billets | 7 2 6 | — |
| Soft Billets | 5 10 0 | — |
| N.W. COAST— | | |
| BARROW— | | |
| Heavy Rails | 8 5 0 | — |
| Light Rails | 8 10 0 to 8 15 0 | — |
| Billets | 6 10 0 to 9 0 0 | — |
| MANCHESTER— | | |
| Bars (Round) | 9 7 6 | — |
| „ (Small Round) | 7 0 0 | — |
| Hoops (Baling) | 10 0 0 | 9 15 0 |
| „ (Soft Steel) | 9 0 0 | 8 15 0 |
| Plates | 8 17 6 to 9 2 6 | — |
| „ (Lancs. Boiler) | 8 10 0 to 8 12 6 | — |
| SHEFFIELD— | | |
| Siemens Acid Billets | 9 2 6 (basis) | — |
| Hard Basic | 8 2 6 and 8 12 6 | — |
| Intermediate Basic | 6 12 6 and 7 2 6 | — |
| Soft Basic | 6 0 0 | — |
| Hoops | 9 10 0 to 9 15 0 | — |
| Soft Wire Rods | 7 10 0 | — |
| MIDLANDS— | | |
| Small Rolled Bars (all British) | 7 5 0 to 7 15 0 | — |
| Small Re-rolled Bars | 6 7 6 to 6 10 0 | — |
| Billets and Sheet Bars | 4 17 6 to 5 7 6 | — |
| Galv. Sheets, f.o.b. L'pool | 9 5 0 to 9 7 6 | — |
| (2) Staffordshire Hoops | 9 10 0 | — |
| (*d*) Angles | 8 7 6 | — |
| (*d*) Joists | 8 15 0 | — |
| (*d*) Tees | 9 7 6 | — |
| (*d*) Bridge and Tank Plates | 8 17 6 | — |
| Boiler Plates | 8 7 6 to 8 10 0 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| SWANSEA— | |
| Tin-plates, I.C., 20 by 14 f.o.b. | 14/9 to 15/3 |
| Block Tin (cash) | 113 15 0 |
| „ (three months) | 116 0 0 |
| Copper (cash) | 27 11 3 |
| „ (three months) | 27 6 3 |
| Spanish Lead (cash) | 9 12 6 |
| „ „ (three months) | 9 18 9 |
| Spelter (cash) | 11 11 3 |
| „ (three months) | 11 16 3 |
| MANCHESTER— | |
| Copper, Best Selected Ingots | 32 0 0 |
| „ Electrolytic | 33 0 0 |
| „ Strong Sheets | 59 0 0 |
| „ Tubes (Basis Price), lb. | 0 0 9½ |
| Brass Tubes (Basis Price), lb. | 0 0 8½ |
| „ Condenser, lb. | 0 0 11 |
| Lead, English | 11 15 0 |
| „ Foreign | 10 2 6 |
| Spelter | 11 15 0 |
| Aluminium (per ton—raw ingot) | £95 |

## FERRO ALLOYS.

| | |
|---|---|
| Tungsten Metal Powder | 2/3½ per lb. |
| Ferro Tungsten | 2/– per lb. |

| | Per Ton. | Per Unit. |
|---|---|---|
| Ferro Chrome, 4 p.c to 6 p.c. carbon | £25 0 0 | 7/6 |
| „ „ 6 p.c. to 8 p.c. | £24 10 0 | 7/– |
| „ „ 8 p.c. to 10 p.c. | £23 15 0 | 7/– |
| „ „ Specially Refined | | |
| „ „ Max. 2 p.c. carbon | £37 10 0 | 12/– |
| „ „ „ 1 p.c. carbon | £47 2 6 | 14/– |
| „ „ „ 0·70 p.c. carbon | £52 0 0 | 14/– |
| „ „ „ carbon free | 1/1 per lb. | |
| Metallic Chromium | 2/9 per lb. | |
| Ferro Manganese (per ton) | £11 0 0 for home | |
| „ „ „ | £11 10 0 for export | |
| „ Silicon, 45 p.c. to 50 p.c. | £13 10 0 scale 5/– per unit | |
| „ „ 75 p.c. | £19 0 0 scale 7/– per unit | |
| „ Vanadium | 12/6 per lb. | |
| „ Molybdenum | 6/3 per lb. | |
| „ Titanium (carbon free) | 9d. per lb. | |
| Nickel (per ton) | £250 to £255 | |
| Ferro Cobalt | 8/9 per lb. | |

## FUELS.

### SCOTLAND.

| | Export. |
|---|---|
| LANARKSHIRE— | |
| (f.o.b. Glasgow)—Steam | 13/– |
| „ „ Ell | 14/3 |
| „ „ Splint | 14/3 to 15/6 |
| „ „ Trebles | 12/– |
| „ „ Doubles | 9/9 |
| „ „ Singles | 8/9 |
| AYRSHIRE— | |
| (f.o.b. Ports)—Steam | 12/– |
| „ „ Jewel | 16/6 |
| „ „ Trebles | 12/6 |
| FIFESHIRE— | |
| (f.o.b. Methil or Burntisland)—Steam | 10/9 to 13/– |
| Screened Navigation | 16/6 |
| Trebles | 13/6 to 14/9 |
| Doubles | 10/6 to 11/3 |
| Singles | 8/9 |
| LOTHIANS— | |
| (f.o.b. Leith)—Best Steam | 11/– to 11/6 |
| Secondary Steam | 11/– |
| Trebles | 13/– |
| Doubles | 10/6 to 11/– |
| Singles | 8/9 |

### (8) N.W. COAST— ENGLAND.

| | |
|---|---|
| Steams | 21/9 |
| Household | 32/6 to 51/8 |
| Coke | 20/– to 22/6 |
| NORTHUMBERLAND— | |
| Best Steams | 13/6 |
| Second Steams | 12/3 to 12/6 |
| Steam Smalls | 8/6 |
| Unscreened | 12/6 to 13/– |
| Household | 27/– to 39/– |
| DURHAM— | |
| Best Gas | 14/6 |
| Second | 13/3 to 13/6 |
| Household | 25/– to 37/– |
| Foundry Coke | 24/– |

| SHEFFIELD— | Inland. | |
|---|---|---|
| Best Hand-picked Branch | 25/– to 26/– | — |
| South Yorkshire Best | 20/– to 21/– | — |
| Derbyshire Best Bright House | 20/– to 21/– | — |
| Screened House Coal | 15/6 to 16/6 | — |
| Best Screened Nuts | 15/– to 16/– | — |
| Small Screened Nuts | 13/6 to 15/6 | — |
| Yorkshire Hards | 16/– to 18/– | — |
| Derbyshire Hards | 16/– to 18/– | — |
| Rough Slacks | 8/6 to 9/6 | — |
| Nutty Slacks | 7/– to 8/6 | — |
| Blast-furnace Coke (Inland) | 11/– to 12/– on rail at ovens | |
| Furnace and Foundry Coke (Export), f.o.b., 14/6 to 16/6 | | |

### (9) SOUTH WALES.

| CARDIFF— | |
|---|---|
| Steam Coals: | |
| Best Smokeless Large | 19/6 to 19/9 |
| Second Smokeless Large | 18/9 to 19/6 |
| Best Dry Large | 19/– to 19/6 |
| Ordinary Dry Large | 17/9 to 18/3 |
| Best Black Vein Large | 18/3 to 18/6 |
| Western Valley Large | 17/9 to 18/– |
| Best Eastern Valley Large | 17/7½ to 17/9 |
| Ordinary Eastern Valley Large | 17/3 to 17/6 |
| Best Steam Smalls | 13/– to 13/6 |
| Ordinary Smalls | 11/– to 13/– |
| Washed Nuts | 19/– to 25/– |
| No. 3 Rhondda Large | 19/6 to 19/9 |
| „ „ Smalls | 15/– to 16/– |
| No. 2 „ Large | 17/– to 17/3 |
| „ „ Through | 15/6 to 16/– |
| „ „ Smalls | 14/– to 14/3 |
| Foundry Coke (Export) | 22/6 to 36/6 |
| Furnace Coke (Export) | 17/– to 18/– |
| Patent Fuel | 20/– |
| Pitwood (ex ship) | 19/– to 20/6 |
| SWANSEA— | |
| Anthracite Coals: | |
| Best Big Vein Large | 36/– to 38/6 |
| Seconds | 27/– to 32/6 |
| Red Vein | 22/6 to 27/6 |
| Machine-made Cobbles | 41/6 to 48/6 |
| Nuts | 40/– to 48/6 |
| Beans | 28/6 to 32/6 |
| Peas | 19/6 to 21/– |
| Breaker Duff | 8/6 to 9/6 |
| Rubbly Culm | 10/– to 10/6 |
| Steam Coals: | |
| Large | 20/– to 20/6 |
| Seconds | 18/– to 20/– |
| Smalls | 11/6 to 13/– |
| Cargo Through | 16/– to 17/6 |

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

# French Engineering Notes.

*(From our own Correspondent in Paris.)*

### Trade Prospects.

THE chief topic of discussion at the present moment is the possibility of finding a way out of the dilemma of a steadily diminishing consumption. There is plenty of iron and steel and other products that could be sold at home and abroad if consumers could only pay for them, and when foreign inquiries are received they are always accompanied by conditions of credit that cannot be accepted, while it is affirmed that even Denmark has been offering to purchase metallurgical goods to be paid for in agricultural produce. As credit has fallen to the lowest possible ebb, it is no longer a factor in trade. Italy has gone to the extent of granting a loan to Turkey for the purchase of Italian machinery and other goods, and an exchange of manufactures for Russian oil, timber, and grain has been carried as far as it is possible to go. In the absence of credit the only thing that industry can do is to limit production to what can be bought and paid for, and to investigate every means of improving foreign exchanges. So far as the iron and steel trades are concerned, French producers find that the dumping of their products abroad has failed, and being unable to do much with the absurdly low prices at which they have been offering bars for shipment at Antwerp French makers have come to the conclusion that there is no hope for the future unless something is done immediately to bring about a European organisation for regulating the production and prices of steel. Everyone knows that this is the only way of avoiding disaster, but there is little prospect of an early solution of the difficulties that have so long prevented the carrying out of an international arrangement. Meanwhile, blast-furnaces are damped down, and the steel output is falling. A general review of the situation will be made at a Congress to be held next week in Paris, when experts will deal with the different economic factors. The Congress will discuss the influences of tariffs, import quotas and other matters in the hope of evolving a programme that will facilitate foreign exchanges. While manufacturers naturally regard Protection by quotas as indispensable to their existence, there is some questioning as to whether such quotas are favourable to the economic interests of a country which is mainly agricultural, and whose industrial interests lie largely outside those of the metallurgical and engineering trades. It is hoped that all these matters will be thrashed out at the Congress, and that something will be done to lay the foundation of a sound economic policy.

### Shipbuilding.

The annual report of the Chambre Syndicale des Constructeurs de Navires gives the usual survey of the world's shipbuilding industry, and states that, so far as France is concerned, it is doubtful if the yards will launch more than 30,000 tons during the present year, exclusive of the big liner at Saint-Nazaire. When the Government promised to help shipbuilders with import duties, if they would combine to rationalise the industry, they formed the Consortium National des Constructions Navales, and having thus carried out their part of the undertaking, shipbuilders are still waiting for the Government to perform its part of the bargain. All that has been done so far is to extend the working of the system of shipbuilding credits. The report insists that more protection should be given to the industry, though even this will not keep French orders at home unless costs are reduced, and for that reason arrangements have been made with plate mills to supply material in competition with foreign ship plates. By standardising material and fittings and reducing their number, it is hoped that French manufacturers will be able to supply everything that is required at prices which will render shipbuilders independent of foreign material. At the same time, the chances of an early recovery of the shipbuilding industry are so small that the Chambre Syndicale is making great efforts to secure a considerable amount of the work at home and in the Colonies, such as tanks and other material for oil storage and distribution, the cost of which will reach something like 650 million francs, and the construction of material for the ports that was formerly obtained largely from Germany on account of reparations.

### Monsieur Marcel Deprez.

There has been celebrated this week the fiftieth anniversary of the first attempt made by the late Monsieur Marcel Deprez to distribute electrical energy over long distances by means of a small experimental plant he had installed at the Conservatoire des Arts et Métiers where he was professor. On that occasion he drove a ¼ horse-power motor from a dynamo through about 50 miles of telegraph wire which he had arranged within the building. Three months later he repeated the experiment at the Munich Exhibition, when he actuated a motor driving a pump by current supplied from a dynamo 35 miles away. Monsieur Marcel Deprez devoted the remainder of his life particularly to problems of long-distance distribution. He established laws governing the distribution of electrical energy and showed the importance of high-tension current. He was largely responsible for the early development of hydro-electrical distribution. He died in 1918 at the age of seventy-five.

### Foreign Trade.

The returns of foreign trade during the first five months of the year have accentuated the feeling that something must be done immediately to avoid disaster. Compared with the similar period of 1931, the imports for the first five months of this year declined by 35 per cent. and the exports by 38 per cent. It was in May that the export trade started to collapse. Imports during the five months were valued at 12,676 million francs, a decline of 6605 million francs, and exports amounted to 8507 million francs, or 5195 million francs less than a year ago. The contraction was particularly marked in the imports of "material necessary for industry," and in the exports of manufactured goods, the latter falling during the year from 8645 million francs to 5236 million francs. The imports of coal declined from 12,175,450 tons to 8,719,485 tons.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

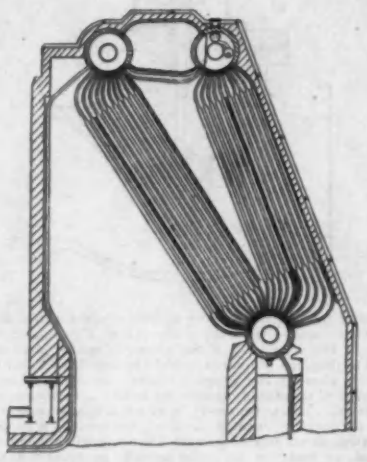
*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

### STEAM GENERATORS.

373,048. October 27th, 1931.—WATER-TUBE BOILERS, *The Stirling Boiler Company, Ltd.*, 32, *Farringdon-street, London, E.C.* 4.

In this boiler the steam generating tubes are swaged down at

Nº 373,048



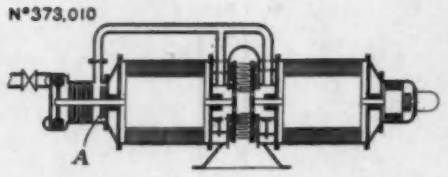
the ends to a smaller diameter, so that they may be the more readily expanded into the drums, and the gas baffles are extended to reach these reduced portions of the tubes. The illustration is self explanatory.—*May* 19*th*, 1932.

### TURBINE MACHINERY.

373,010. July 27th, 1931.—MIXED-FLOW STEAM TURBINES, *H. G. C. Fairweather*, 65, *Chancery-lane, London, W.C.* 2.

The general idea is to use the drop of pressure in the high-pressure stages in an axial-flow turbine, as shown on the left of the drawing, and then to use the comparatively low-pressure

Nº 373,010



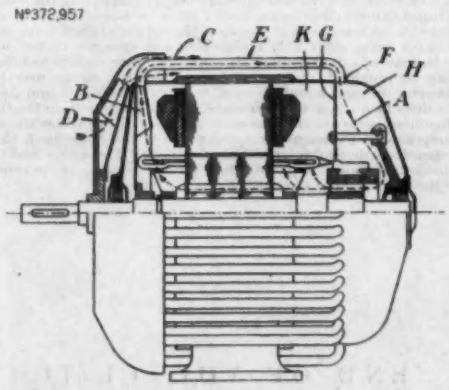

steam in a turbine of the Ljunström type. There arises the balancing of the end thrust on the turbine shaft, and this is effected by the dummy A. This dummy is subject to the exhaust pressure of the axial-flow turbine on one side and to "the falling pressure on the packing on its opposite surface." No hint is given in either the drawing or the specification as to how this falling pressure is maintained.—*May* 19*th*, 1932.

### DYNAMOS AND MOTORS.

372,957. May 20th, 1931.—AN ENCLOSED DYNAMO-ELECTRIC MACHINE HAVING A CIRCULATING INTERNAL CURRENT AND AN EXTERIOR CURRENT OF COOLING AIR, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

The broken line A indicates an inner current of air circulated by the fan B and the broken line C an outer air current driven by the fan D. In the path of the external current of air C there

Nº 372,957



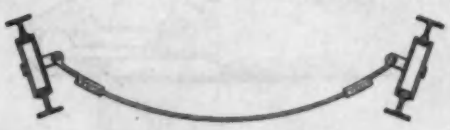

are U-shaped tubes E, traversed by the inner current of cooling air, the tubes being distributed more or less uniformly around the whole of the stator. The radially extending ends F of the tubes are sweated into the casing of the machine, and are expanded like boiler tubes. They have very thin walls and a diameter of, for example, only 1 cm. to 3 cm., according to the size of the machine. The interior of the machine is divided by means of the partition G into a small ante-chamber H for the entering inner air current A and a main chamber K containing the magnetic members. When the commutator is omitted, the inner edge of the wall G extends close to the shaft of the machine, a narrow passage being left between the shaft and the wall for the entry of the air into the chamber K. The special advantage is obtained that in the chamber K a substantially lower air pressure prevails than in the chamber H, so that the air, already cooled on passing through the tubes E and collected in the ante-chamber H, is still more strongly cooled by expansion upon passing into the main chamber K, while the formation of eddies hampering the admission of cooling air at the parts of the machine to be cooled is almost completely avoided. The invention also possesses the special advantage that for the enclosed machine described, the usual open machine models can be adopted almost without change, all that is necessary being the addition of the covering caps and U-shaped tubes.—*May* 19*th*, 1932.

### CRANES AND CONVEYORS.

372,945. May 9th, 1931.—BELT CONVEYORS, F. J. West, E. West, and West's Gas Improvement Company, Ltd., Albion Ironworks, Miles Platting, Manchester.

Instead of the belt of a conveyor being supported by idler

Nº 372,945



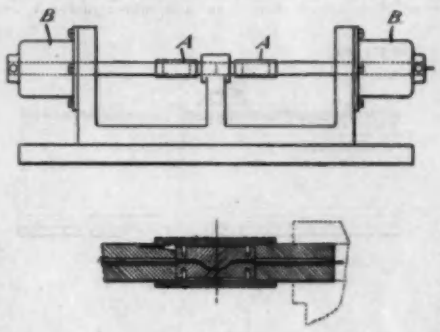
rollers from underneath, it is suspended, like a hammock, from pulleys carried by brackets clipped to its edges. Only one of several alternative arrangements is shown in the drawing.—*May* 19*th*, 1932.

### MACHINE TOOLS AND SHOP APPLIANCES.

373,079. December 14th, 1931.—WIRE STRAIGHTENERS, *R. M. Hughes*, 72, *Cannon-street, London, E.C.* 4.

It is insisted in this specification that the straightening blocks should be driven by motors, electric or otherwise, directly con-

Nº 373,079



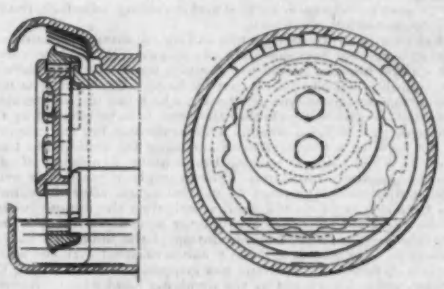

nected with their spindles. The straightening blocks are of the familiar form shown in the detail sketch and are held in the sleeves A A. They are rotated in opposite directions by means of the motors B B.—*May* 19*th*, 1932.

### TRAMWAYS AND RAILWAYS.

372,707. January 1st, 1932.—AXLE-BOXES, W. Peyinghaus, Eisen- und Stahlwerk Walter Peyinghaus, Egge, near Volmarstein a.d. Ruhr, Germany.

It is suggested in this specification that with ring-oiled bearings on vehicles, such as tramway trailers, the viscosity of the lubricating oil may produce such a resistance to traction that the vehicles cannot be man-handled. As a consequence, the inventor adopts "a ring-lubrication arrangement for the axle

Nº 372,707



bearings of rail vehicles, having an internally toothed lubricating ring, which runs on an externally toothed pinion located in front of the end of the axle journal, characterised by the feature that the crowns of the teeth of the pinion are in the form of knife edges and the gaps between the teeth of the ring in the form of notches, so that the ring runs over the pinion with practically no friction." When running slowly, the oil drips off the conical face of the ring, and when going fast is thrown off by centrifugal force from the rim.—*May* 12*th*, 1932.

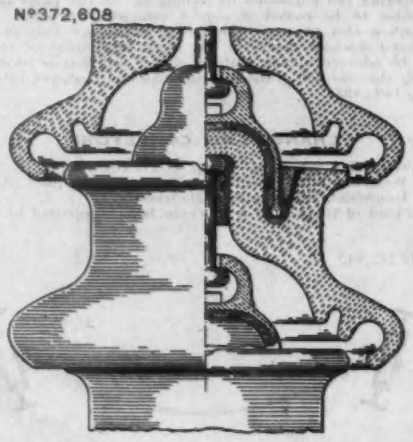
### MISCELLANEOUS.

372,608. June 29th, 1931.—ELECTRIC INSULATORS, William George Thompson, of 6, Guildford-place, Newcastle-on-Tyne.

This invention is concerned more particularly with insulators built up of a number of units. According to the invention a unit is provided with upper and lower flanges connected by a waist portion, the flanges being so shaped that they respectively co-operate with the flanges of adjacent units to provide an insulator in which the outer surfaces of the co-operating parts of adjacent units are substantially streamlined with respect to air currents

flowing past these parts. It has been found that the fouling of insulators, owing to the deposit of dirt thereon, tends to take place where eddies are formed in the air currents flowing past the insulator, such eddies being due to the fins or other irregularities in the surface of the insulator. When, therefore, the eddies in the air currents are minimised by streamlining the outer surface of the insulator in accordance with the invention, the dirt deposited on the insulator is very considerably reduced. Preferably each unit consists of a body portion having a rain

No 372,608

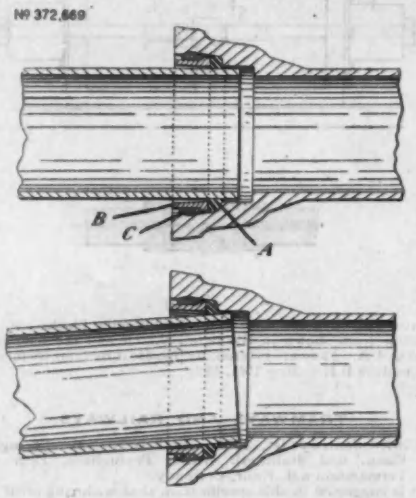


shed formed at its lower end and a flange at its upper end, the flange co-operating with the rim of the rain shed of the unit above to form the desired streamlined outer surfaces. Conveniently the rain shed and flange are so shaped and dimensioned that the flange of one unit lies within the rim of the rain shed of the unit above it and is separated therefrom by an annular gap which is substantially perpendicular to the axis of the insulator and thus does not impede the flow of air currents past the insulator.—*May 12th*, 1932.

372,669. September 18th, 1931.—PIPE JOINTS, The Staveley Iron and Coal Company, Ltd., Staveley, near Chesterfield, and P. W. Fawcett, The Homestead, Hope, Derbyshire.

This spigot and socket joint is intended to provide a certain degree of flexibility and yet maintain a tight joint. At the bottom of the socket there is an india-rubber gasket A, which

No 372,669

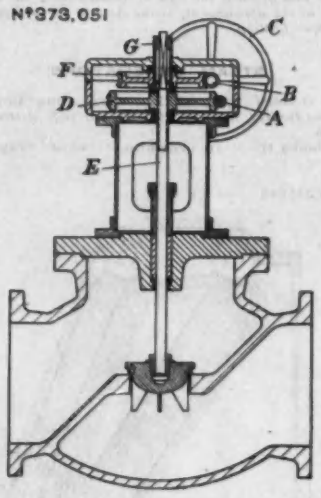



makes a tight joint between the two lengths of pipe. This gasket is forced down in place by the ring B, which is made tight in the socket by the lead caulking C. It will be seen that space is allowed for the angular movement of the pipe without disturbing the lead caulking.—*May 12th*, 1932.

373,051. October 28th, 1931.—ELECTRICALLY OPERATED VALVES, Siemens-Schuckertwerke Aktiengesellschaft, Berlin-Siemensstadt, Germany.

Valves with a rotatable spindle and a rotatable spindle nut each having a driving device are already known. With these valves the spindle nut can be set into rotation by an electromotor and the spindle itself can be rotated by hand. The spindle is held fast or released by means of a brake, which has to be separately operated, according to whether the drive is to be effected by the motor or by the hand wheel. This brake can be, for example, in the form of a two-part bush enclosing the hub of the hand wheel. When using a special brake quite a number of disadvantages are encountered. For example, if the fact is overlooked that the brake must be applied again, after the spindle has been displaced by the hand wheel, then the remote control of the valve through the electromotor is ineffective. Furthermore, a temporary false manipulation of the brake can lead to accidents. For instance, if the brake is released with the motor running before the attendant has gripped the hand wheel, the attendant can be injured by the revolving hand wheel. According to the invention, these disadvantages are obviated by interposing a self-locking gear element between the hand wheel and the spindle so that each driving device contains a self-locking gear element. The hand wheel, which thus normally remains stationary, permits additional adjustment of the spindle by hand without trouble or danger even when the motor is running. The motor drive is effected through the worm A and the hand drive through the worm B and the hand wheel C. The worm A of the motor meshes with the worm wheel D, which is screw-threaded upon the spindle E of the valve. The worm wheel F with which the hand wheel worm B meshes comprises a sleeve G, which is displaceably mounted upon a squared portion of the spindle. The method of operation of this arrangement is as follows :—When the motor worm A rotates the worm wheel D turns and screws the spindle E upwards or downwards, whilst

No 373,051

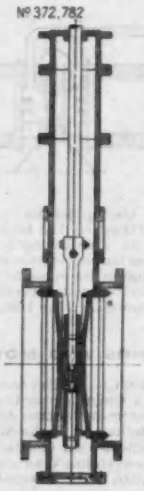



the square part of the spindle is held against rotation by the sleeve G connected with the worm wheel F owing to the self-locking of the worm B. If the motor is out of gear and it is desired to displace the valve spindle by hand the hand wheel C is turned, whereby the worm B rotates the worm wheel F and the spindle E is rotated on account of the square connection of the sleeve G. The worm wheel D, which is held stationary owing to the self-locking worm A, acts in this case as a spindle nut. This arrangement may be provided with an end cut-out which is operated, as soon as the valve spindle presents resistance to further rotation, by the motor worm moving axially owing to its engagement with the stationary worm wheel D.—*May 19th*, 1932.

372,782. February 11th, 1931.—VALVES, A. R. Taylor, Norton Hall, The Green, Norton-on-Tees, Durham ; and Imperial Chemical Industries, Ltd., Imperial Chemical House, Millbank, London, S.W. 1.

This invention relates to wedge-operated valves in which the valve closure is tightened and leakage prevented by means of discs or plates adapted to be pressed against their seats by means of wedges. Such wedge-operated valves suffer, say the inventors, from the defect that errors in alignment of the seats, due to faulty machining or caused by mechanical or temperature stresses, are not compensated by the operating mechanism, so that leakages are liable to occur. According to the invention,

No 372,782

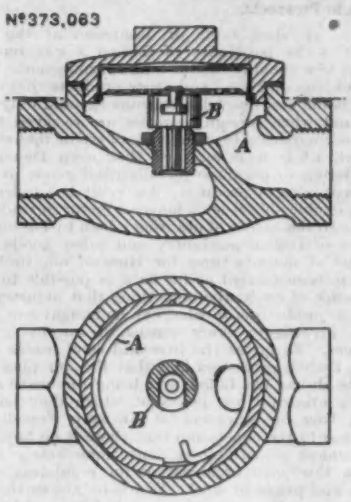


in a valve of the type described the thrust exerted by the wedge is transmitted to the closing disc by means of a coaxial spherically seated loose intermediate member, the spherical seating for that member being preferably replaceable and attached to the disc. In the case of a double-disc valve two such intermediate members may be provided, one for each disc, and the wedge may act between the said members so as to force them apart and press the discs firmly against their seats. Any deviation from the true alignment occurring in the seats of the discs will be automatically compensated by angular displacement of the discs upon their respective spherical intermediate members. The wedge and the spherical seatings are plainly shown in the drawing at the centre of the valve.—*May 11th*, 1932.

373,063. November 12th, 1931.—STEAM TRAPS, A. Davies and Sons, Ltd., Worsley-street, Salford, and G. Davies.

This invention is concerned with that type of trap which is operated by the "breathing" of a capsule containing a volatile

No 373,063




liquid, which is attached to the outlet valve. The essential features are that the capsule is held in place in the trap casing by the spring ring A and that it is attached to the valve in a more or less free manner by the stud and socket B, which allow a certain degree of lateral relative motion.—*May 19th*, 1932.

## Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Tuesday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS : WEST MIDLAND DISTRICT.—Meeting at Stratford-on-Avon. Assemble at front entrance Shakespeare Memorial Theatre. 3 p.m.

TO-DAY AND SATURDAY, JUNE 25TH.

BRITISH WATERWORKS ASSOCIATION.—Bournemouth. Annual general meeting and conference. For programme see page 422.

SATURDAY, JUNE 25TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South-Eastern District, Junior Section, meeting at Canterbury. Assemble at Broad-street Car Park, Canterbury, 2.30 p.m.

FRIDAY, JULY 1ST.

OVERHEAD LINES ASSOCIATION.—Summer meeting at Chesham. For provisional programme see page 513.

SATURDAY, JULY 2ND.

INSTITUTE OF BRITISH FOUNDRYMEN : LANCASHIRE BRANCH.—The annual picnic to Liverpool and New Brighton. Particulars from Mr. El'is Flower.

DIESEL ENGINE USERS ASSOCIATION.—Summer Meeting. Visit to m.v. "Asturias" at Southampton. Presidential Address by Mr. C. M. Mayson.

MONDAY TO TUESDAY, JULY 4TH TO 12TH.

INTERNATIONAL ELECTRICAL CONGRESS, 1932.—Particulars may be obtained by intending British visitors from the Secretary of the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2.

TUESDAY, JULY 5TH, TO SATURDAY, JULY 9TH.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.—Royal Show at Southampton.

THURSDAY, JULY 7TH.

BRITISH ELECTRO-FARMING CONFERENCE.—Members' Tent, Show Yard, Royal Agricultural Society, Southampton. 3 p.m.

WEDNESDAY, AUGUST 31ST, TO WEDNESDAY, SEPTEMBER 7TH.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—Annual meeting at York. President, Sir J. Alfred Ewing, F.R.S. Particulars may be obtained on application to the secretary, British Association, or to the hon. local secretaries, British Association, The Guildhall, York.

SATURDAY, SEPTEMBER 24TH.

ALL-BRITISH EXHIBITION.—Copenhagen, Denmark. Opening.

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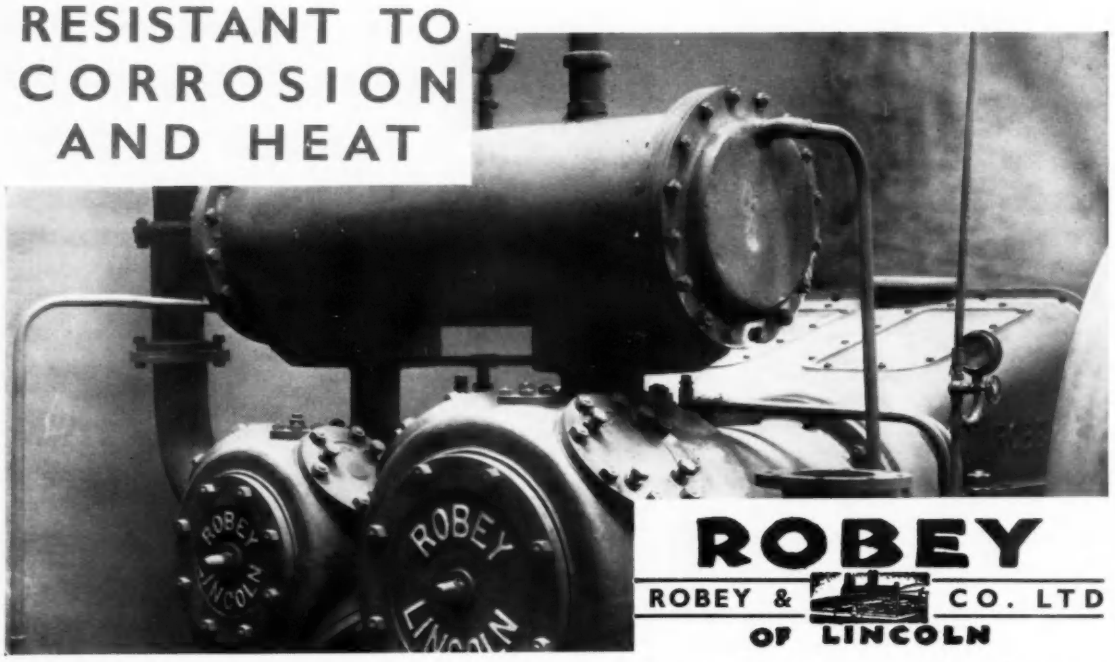


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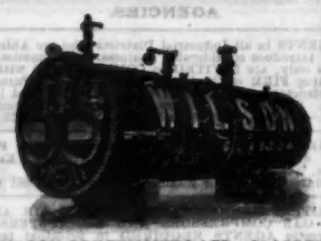

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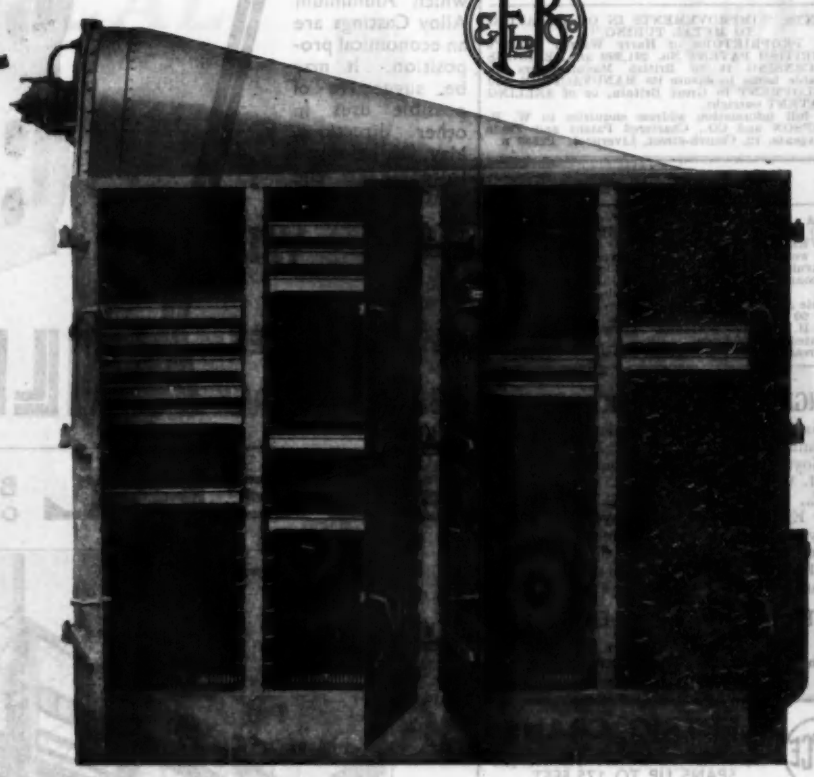

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## MISCELLANEOUS

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70 H.P., 440-Volt D.C. MOTOR, by Siemens, 874 r.p.m., compound wound.
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16 N.H.P. LOCO. TYPE BOILER, by Robey and Co., 100 lb. w.p.
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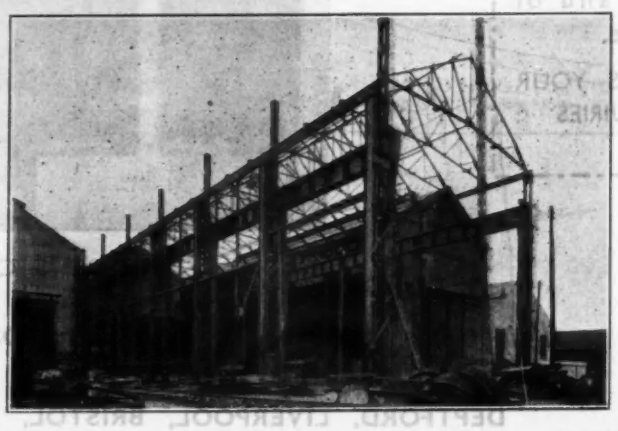
**STEEL** BUILDINGS, ROOFS OF ALL DESCRIPTIONS.



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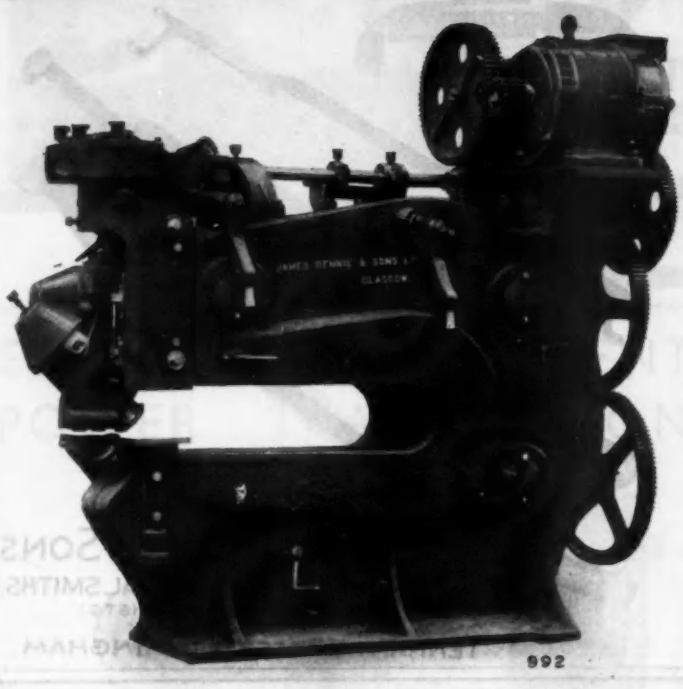


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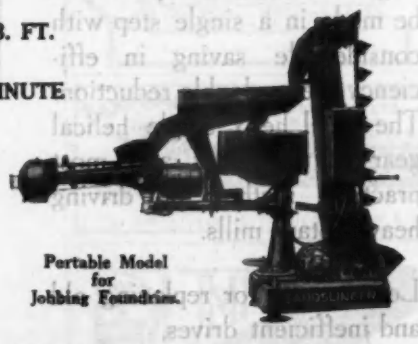

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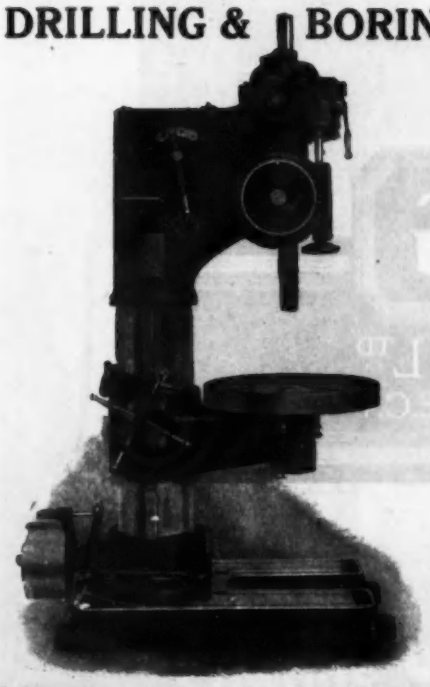

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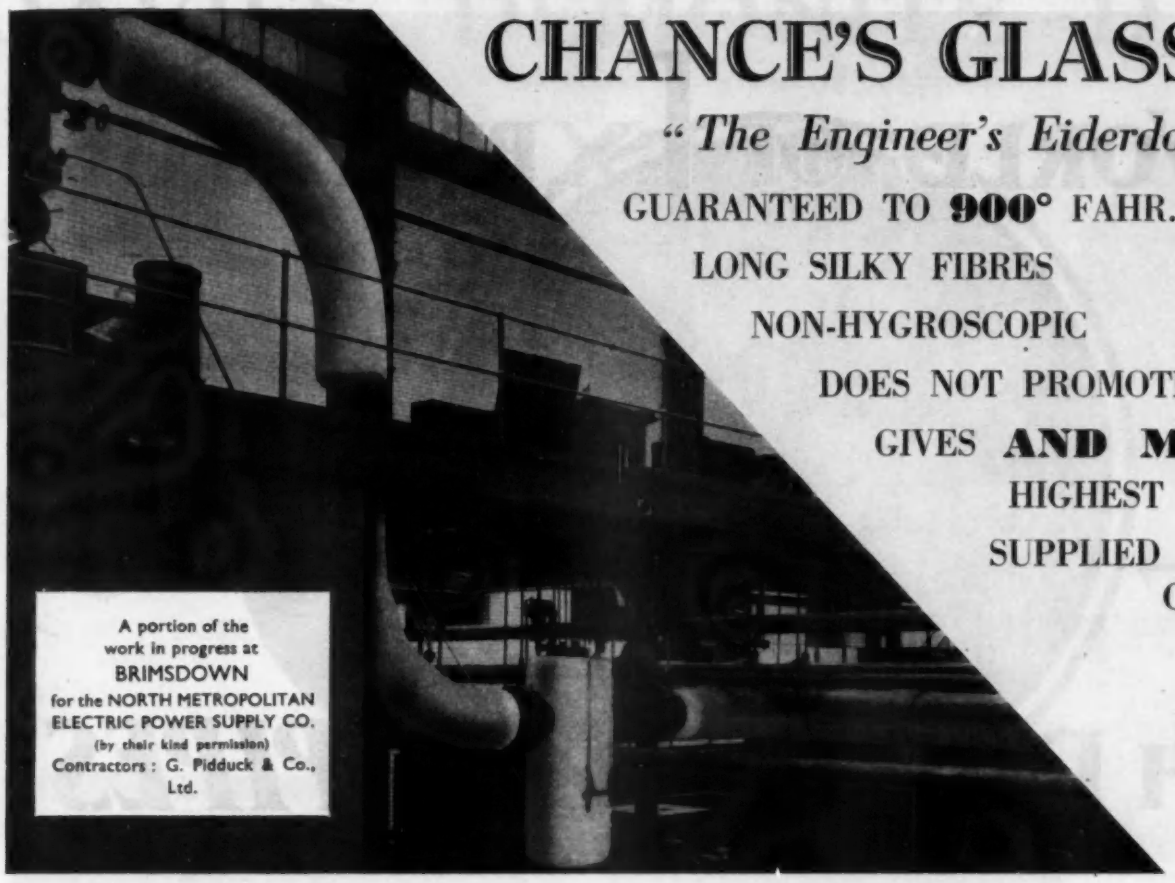

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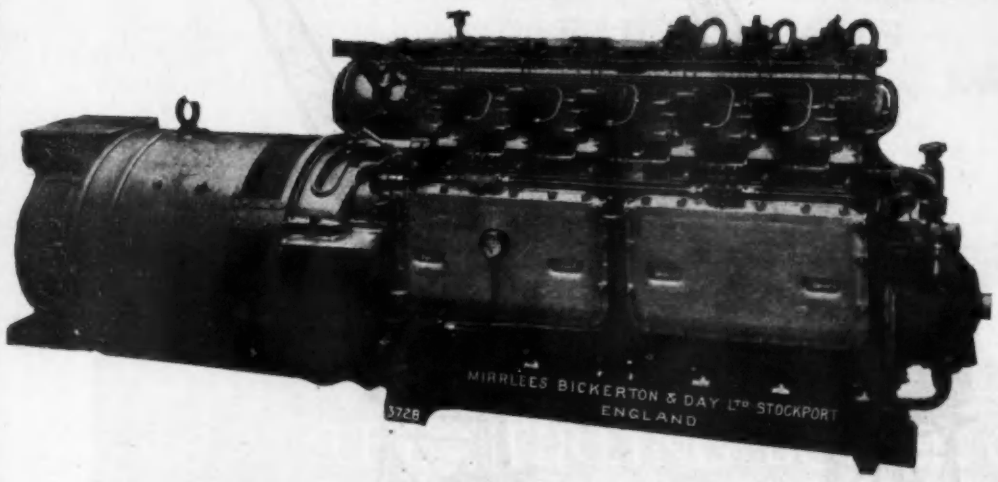


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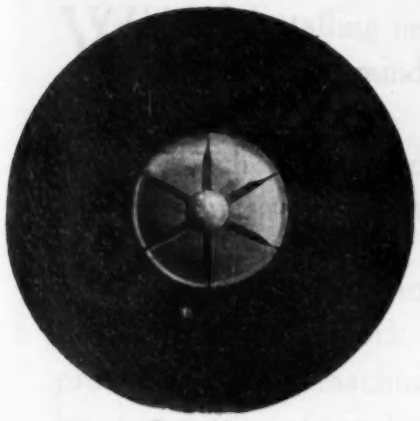

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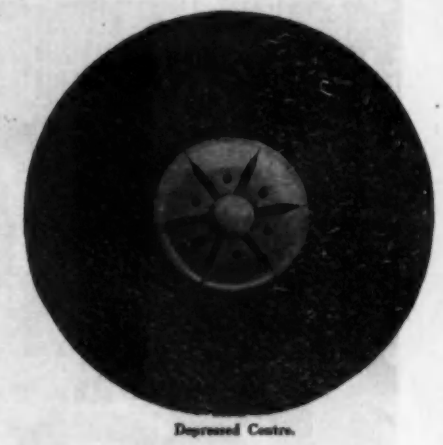

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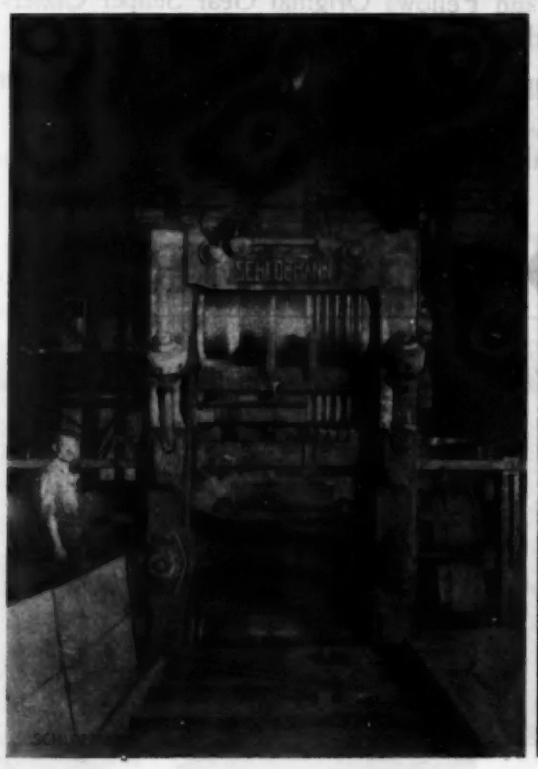

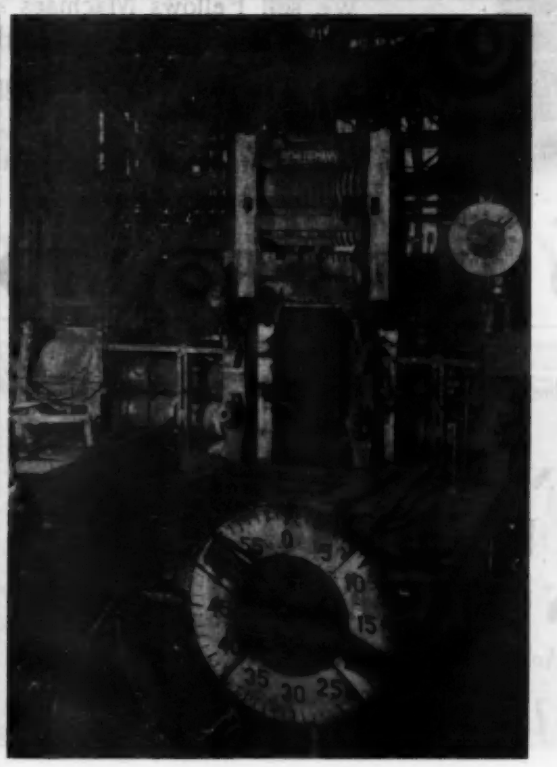

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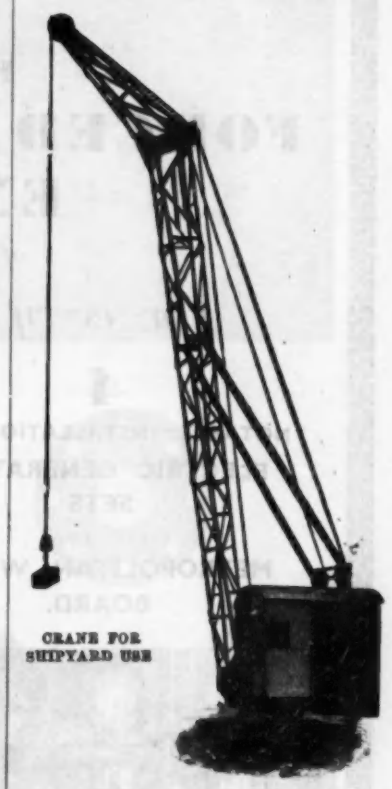

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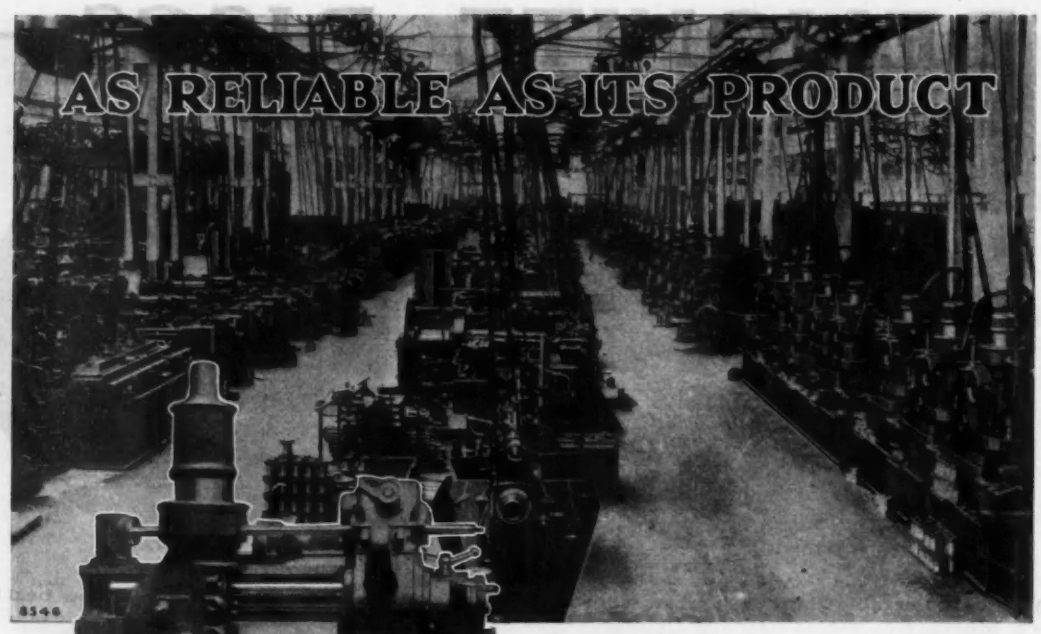
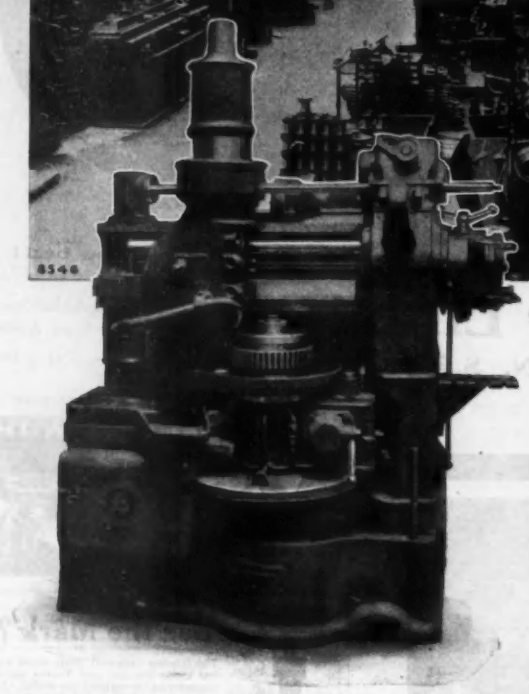



The Gear Cutting Department in our Works at Coventry.



The Fellows No. 61A High Speed Gear Shaper. 18" × 5" face.

WE use 22 Fellows Gear Shapers in our works for cutting silent and accurate gears for use in our own machine tools and for customers.

We sell Fellows Machines and Fellows Original Gear Shaper Cutters, the most accurate tools of their kind.

We also supply gears complete or cut the teeth on customers' own blanks.

If you want to know anything about gears and gear-cutting—ask our Fellows specialist.

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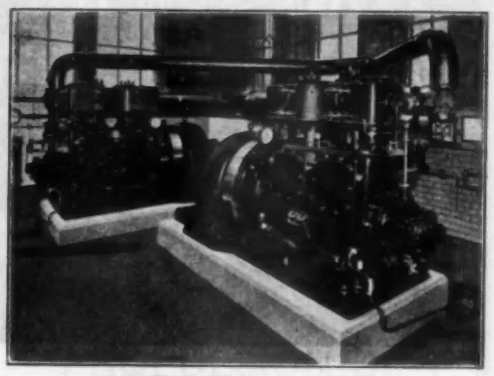
# FORCED LUBRICATION ENGINES

*of the very highest class*

*For every Trade and Industry.*



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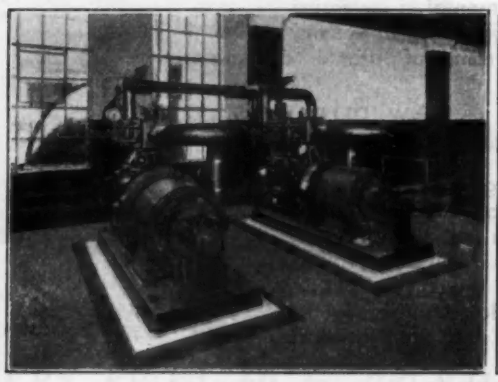
**4**

NOTABLE INSTALLATIONS OF ELECTRIC GENERATING SETS *for the* METROPOLITAN WATER BOARD.



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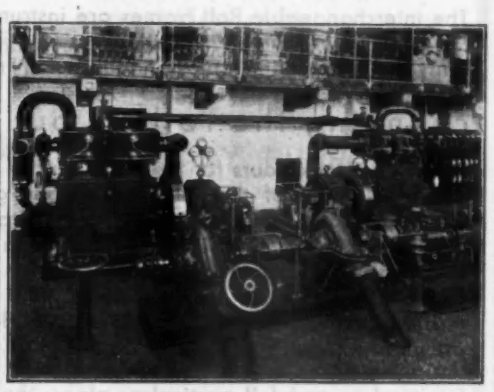
OPENED BY H.M. THE KING, JUNE, 1925.



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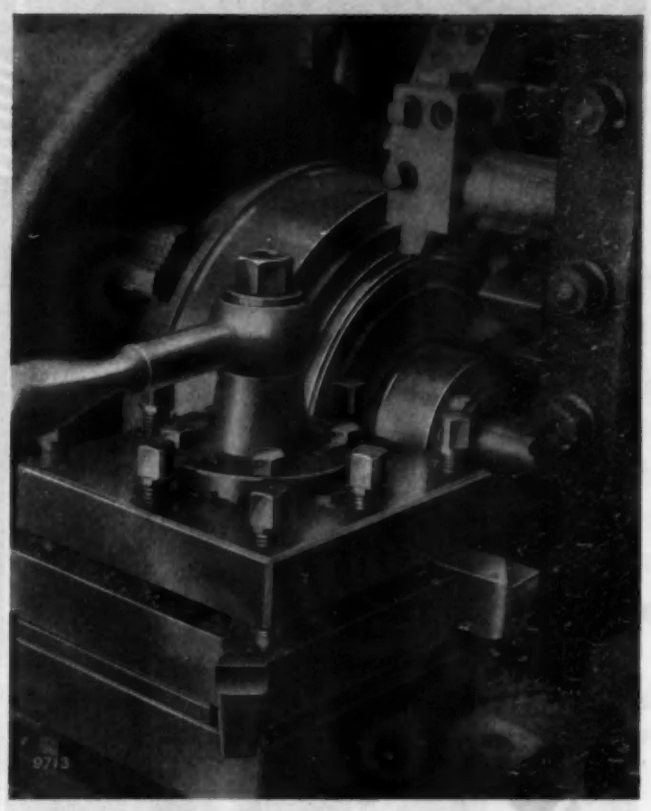
WHEN installing new plant, engineers should bear in mind that modern high-speed cutting alloys require machines having much greater power, stability and rigidity than used to be thought necessary.

Progressive firms are now installing bigger machines to do work in half the time previously taken, machines which will still be earning a profit in ten years' time.

Buy machines for what they will do—Herbert Capstan and Turret Lathes, capable of using tungsten-carbide tools to the limit of their endurance.

**SEE WHAT WE HAVE ACHIEVED WITH THESE MACHINES IN OUR WORKS AT COVENTRY.**



Herbert No. 10 Combination Turret Lathe taking seven cuts simultaneously in cast iron (200 Brinell). Total depth of cut 1⅛". Cutting speed 220 feet per minute on outside dia. (15"). Feed 42 cuts per inch. Hole 5¼" dia. by 5¼" long bored to an accuracy of ·0007" with single point tool. Tungsten-Carbide Tools used throughout.

# ALFRED HERBERT LTD. COVENTRY

# THE METALLIC MANUFACTURING Co LTD
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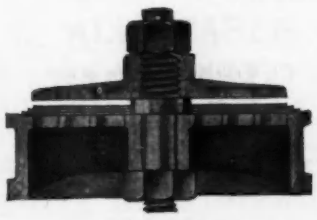

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Soft annealed. Of all sizes, shapes and sections.

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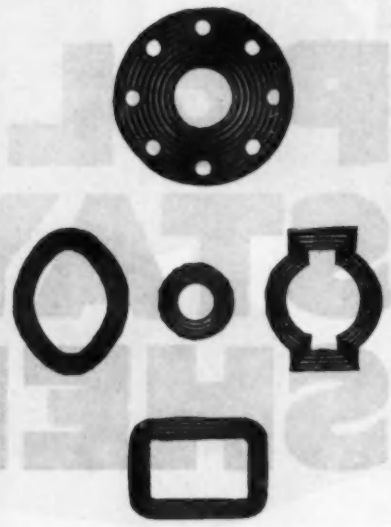
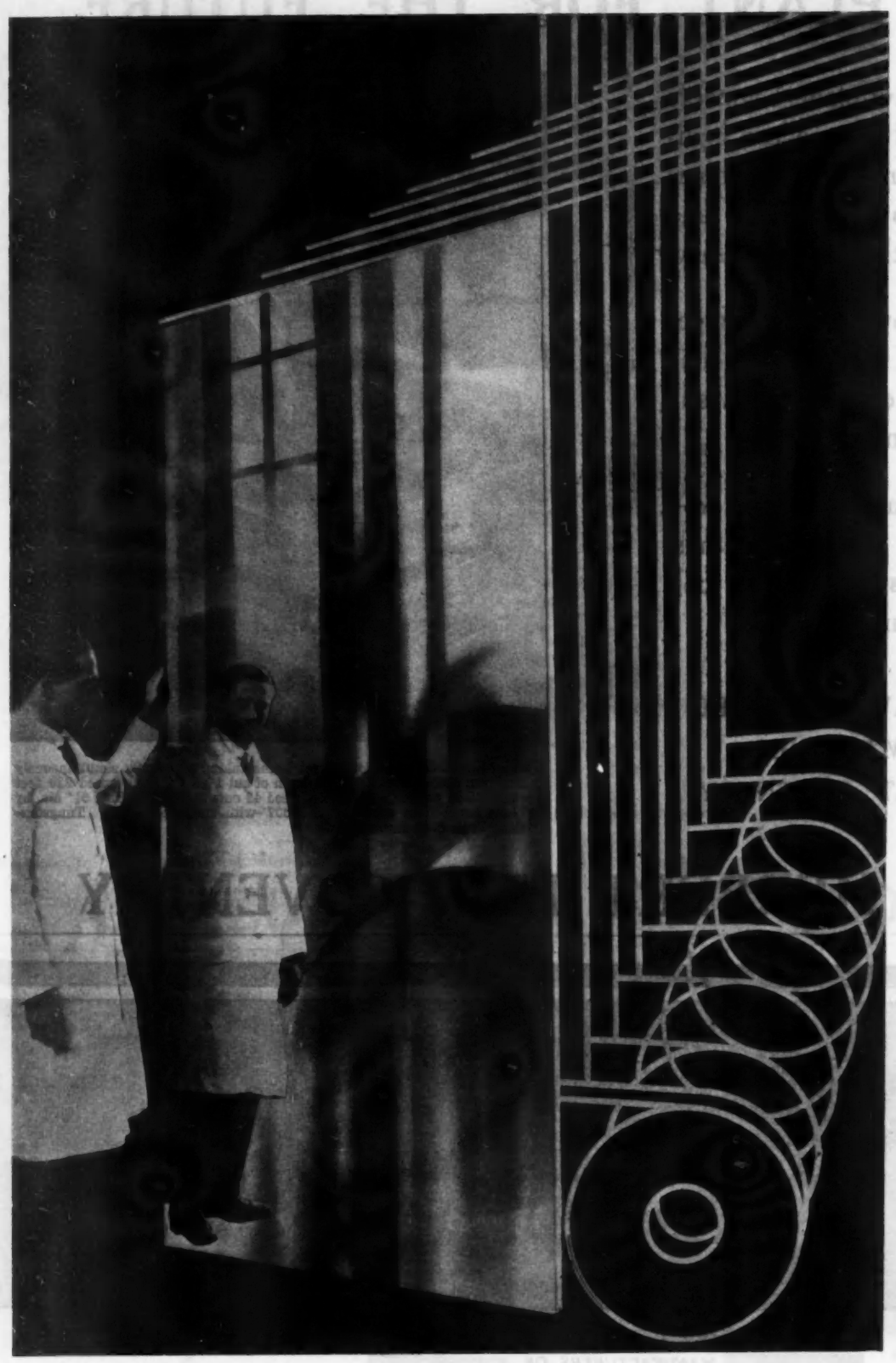


CORRUGATED METALLIC JOINTS.



DURING the development of various applications of rustless steel, it has been found that working from polished sheets or strip is the key to economic production.

The polishing service offered by our Blackheath Works is being more and more extensively used by manufacturers in many trades, and we invite all sheet-metal workers to investigate the opportunities offered in working from polished sheets of Firth Staybrite, for articles and component parts for both industrial and household needs.

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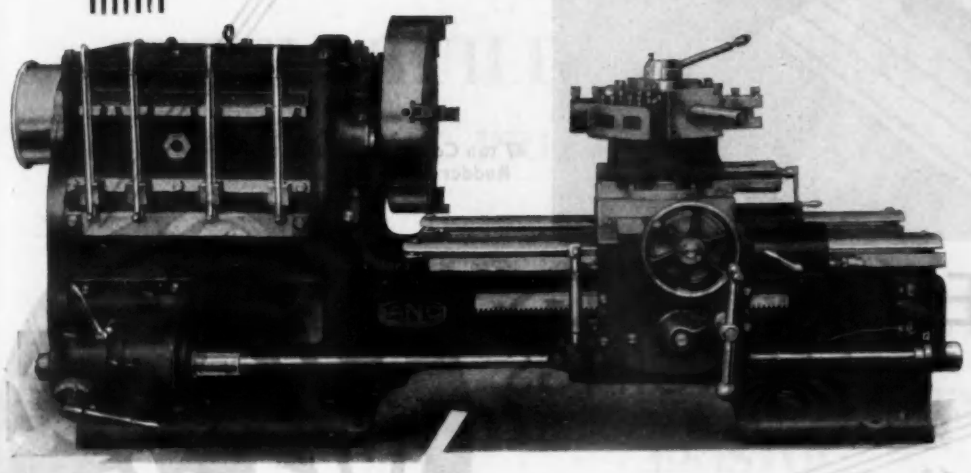

The centre lathe is out of date for chuck work—a Surfacing and Boring Lathe is suitable for machining single pieces as well as for quantity production, but—

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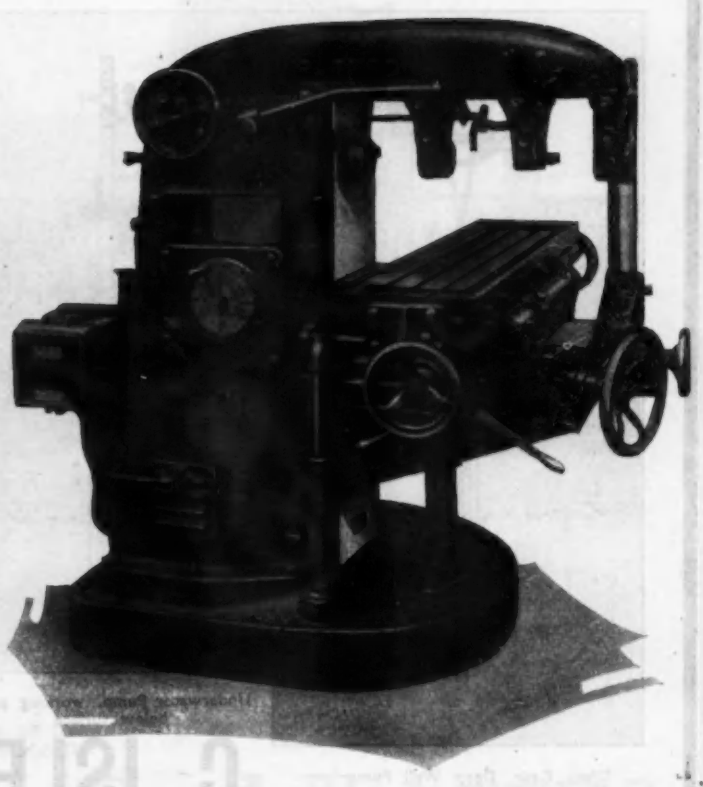

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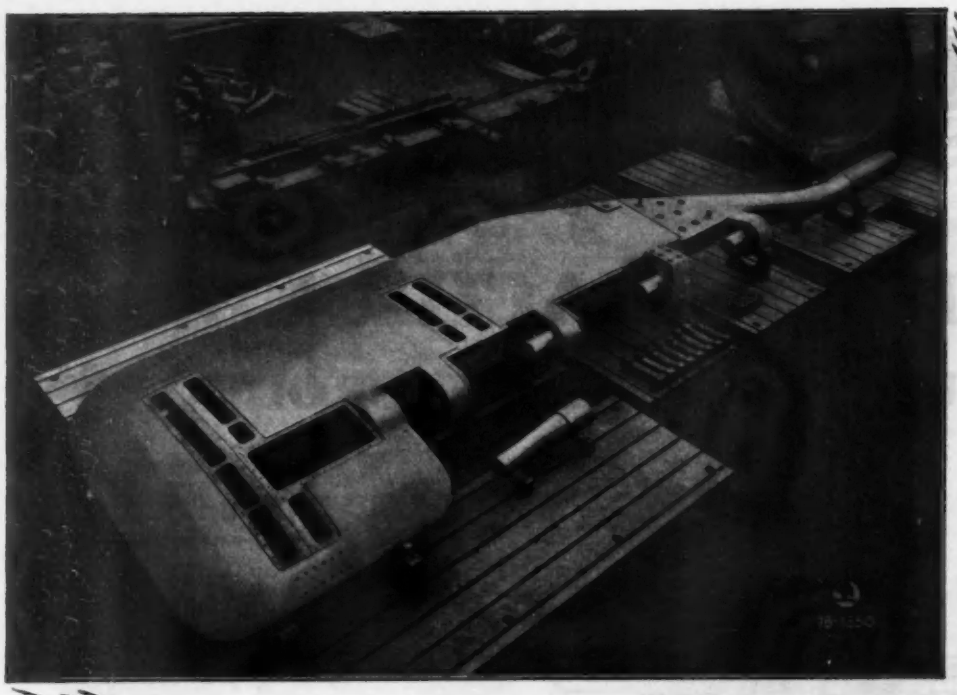

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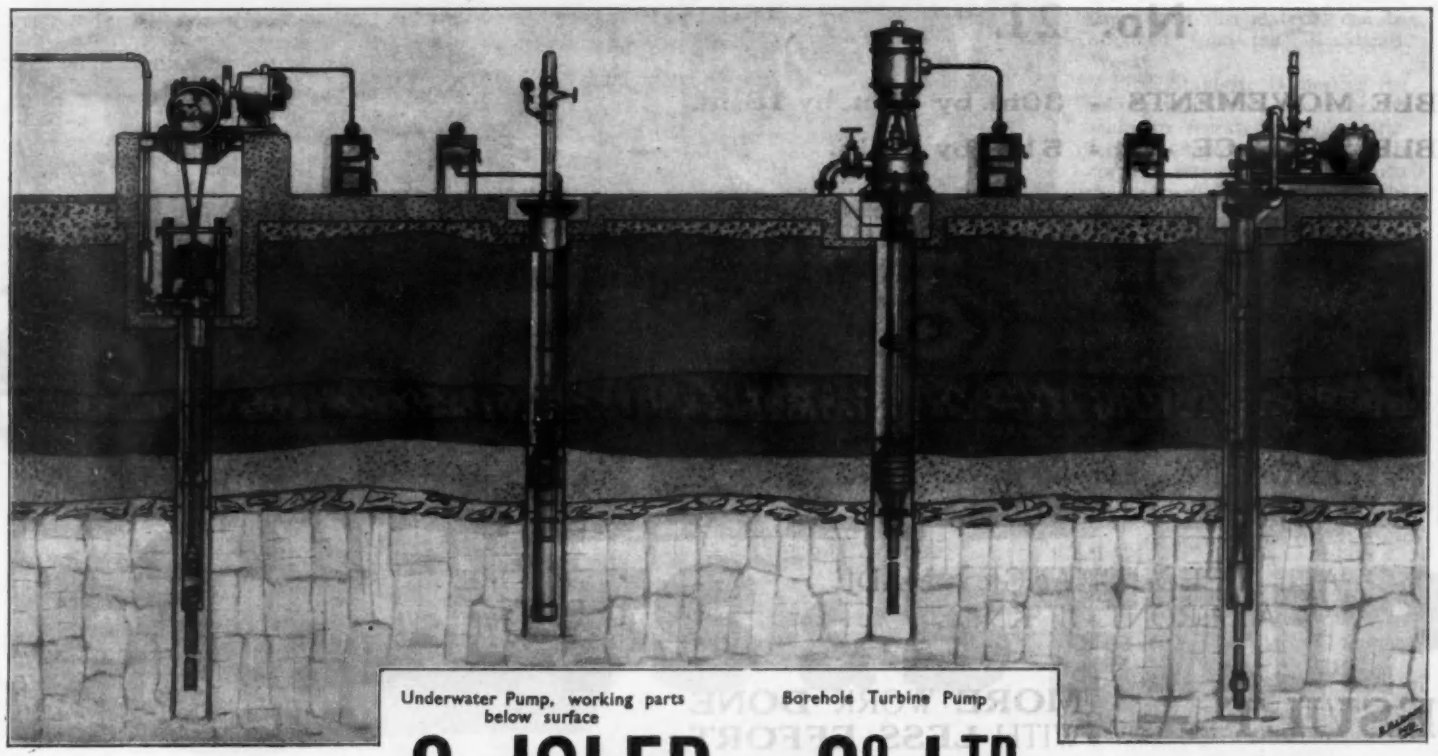

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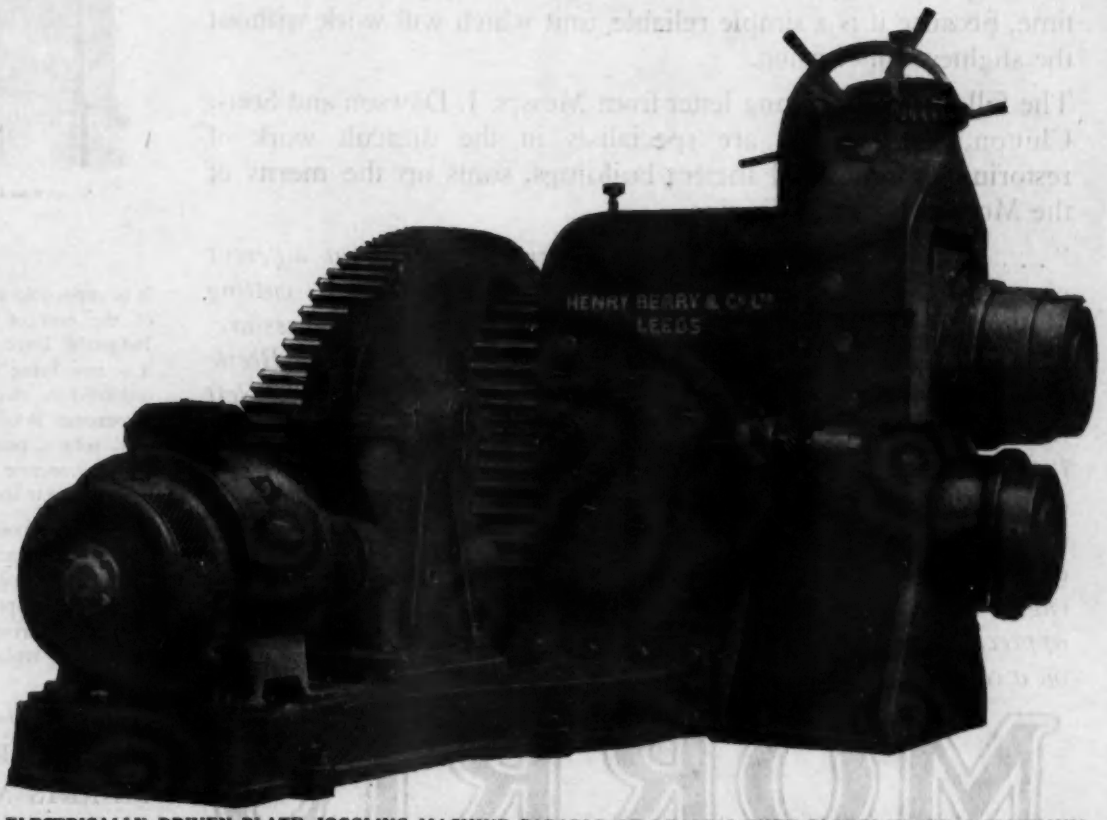


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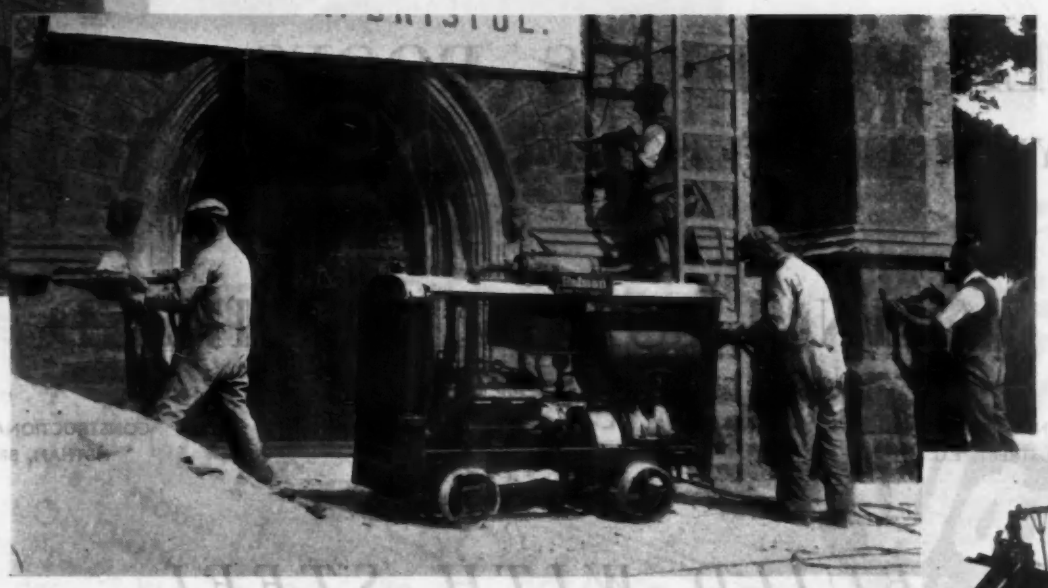

*Brixham Parish Church, Devon. Showing defective joints and stone being cut out with the aid of a Morris engined Holman Compressor and Holman pneumatic tools.*

*Shaugh Prior Church, Plymouth.*

With everyone cutting contract costs to the finest practical limits, the Morris Industrial Engine is becoming more and more widely used for all industrial purposes; replacing more costly units and old-fashioned hand labour. For the Morris Industrial Engine represents economy in three vital forms. First, in initial outlay and comprehensive equipment. Second, in thrifty running and long, trouble-free service. Third, in actual man-time, because it is a simple reliable unit which will work without the slightest supervision.

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*". . . The set is used continually all over the country at different churches, etc., for supplying air for driving pneumatic tools—cutting out defective stone and joints, cement grouting under pressure, spraying liquids for wood and stone, including Death Watch Beetle fluids, waterproofing fluids, etc. The set is filled up and left running unattended for hours at a time. It is most economical in fuel and uses not more than ½ pint of oil and approx. 6 gallons of commercial petrol in an 8-hour day. This set does work in* one *hour which previously took* nine *hours by hand labour, and it is certainly a very sound investment. One splendid feature about this engine is the clutch coupling up the compressor, and to thoroughly appreciate this, one has only to try and start up a clutchless 'turnout' on a cold day . . ."*

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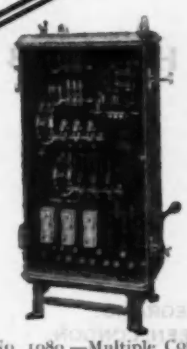

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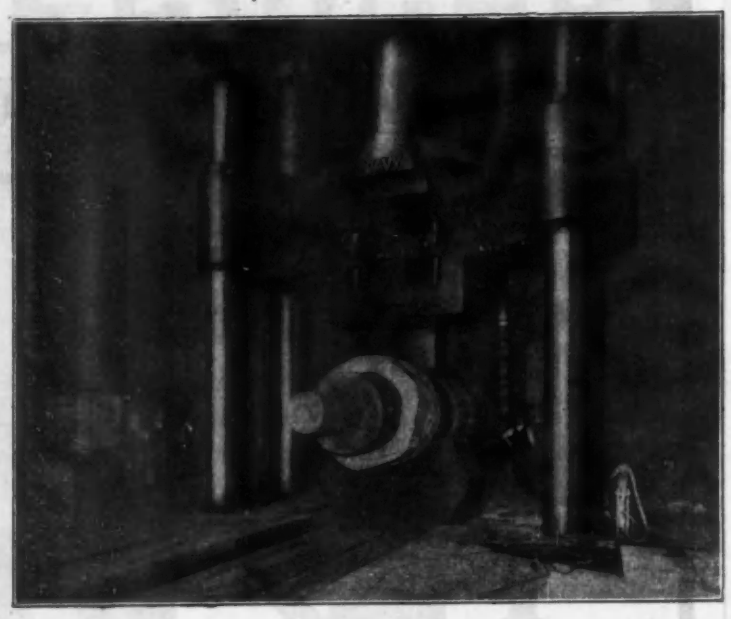

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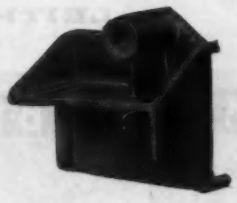

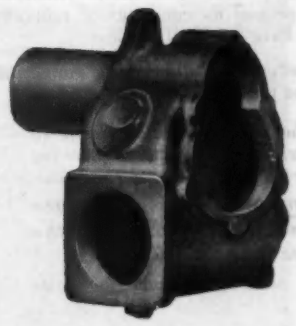

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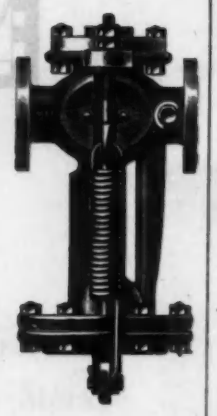

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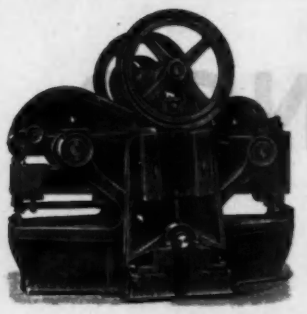

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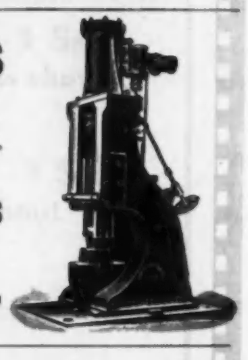

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***"The average monthly cost of steam power for the last three months that the plant was in use was £4,557 6s. 1d.***

*"The yearly gas plant production and costs were as follows:*

| Year | Total K.W. Hours. | Cost per Unit. | Total Cost for Year. | Nett running Time % |
|---|---|---|---|---|
| 1922 | 4,964,416 | ·754d. | £15,731 19s. 2d. | 98·47% |
| 1923 | 5,036,098 | ·588d. | £12,464 7s. 7d. | 98·40% |
| 1924 | 5,324,810 | ·535d. | £11,873 18s. 3d. | 98·50% |
| 1925 | 5,410,230 | ·529d. | £11,924 17s. 2d. | 98·50% |
| 1926 | 5,200,490 | ·484d. | £10,500 14s. 8d. | 98·75% |

Later information from the Mine reveals the following:—

| Year | Total K.W. Hours. | Cost per Unit. | Total Cost for Year. | Nett running Time % |
|---|---|---|---|---|
| 1927 | 5,103,070 | ·491d. | £10,446 4s. 10d. | 98·99% |
| 1928 | 5,847,750 | ·449d. | £10,935 17s. 0d. | 98·91% |
| 1929 | 5,704,000 | ·430d. | £11,468 2s. 0d. | 98·43% |
| 1930 | 5,867,754 | ·440d. | £11,697 10s. 10d. | 74·72% |

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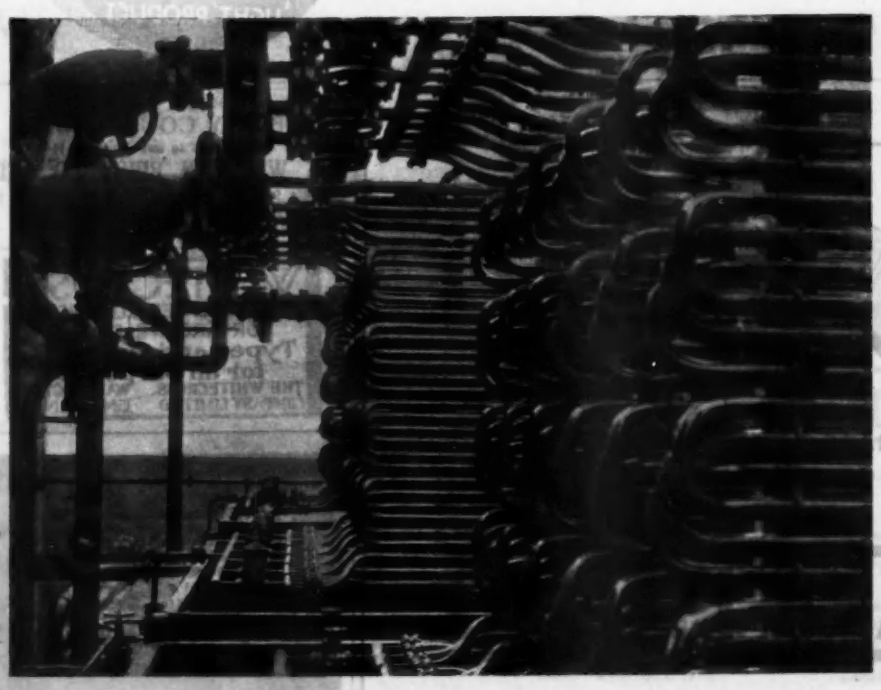

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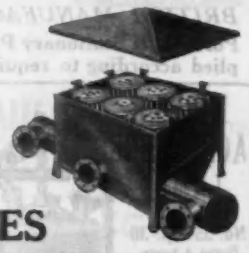

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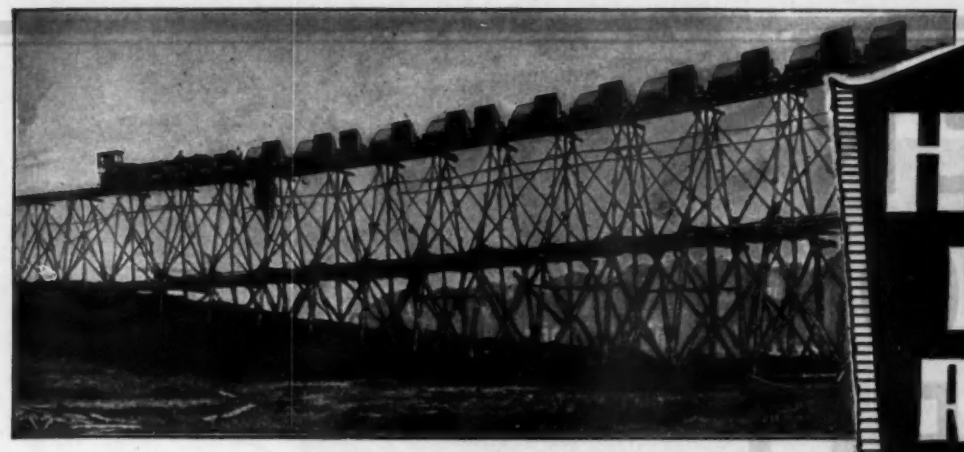

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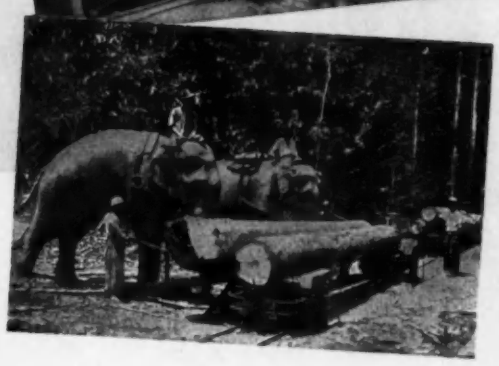

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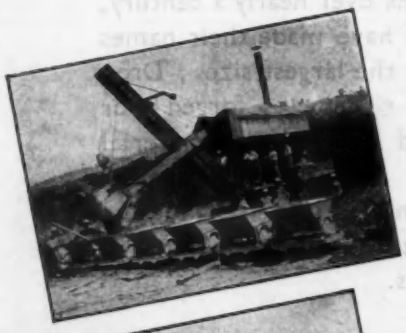

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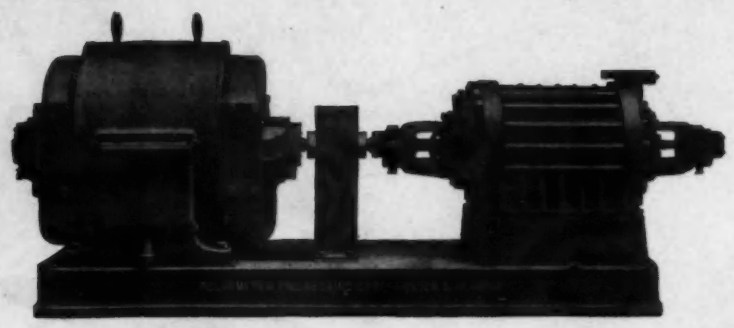

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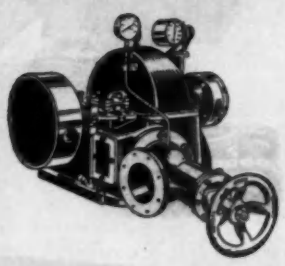

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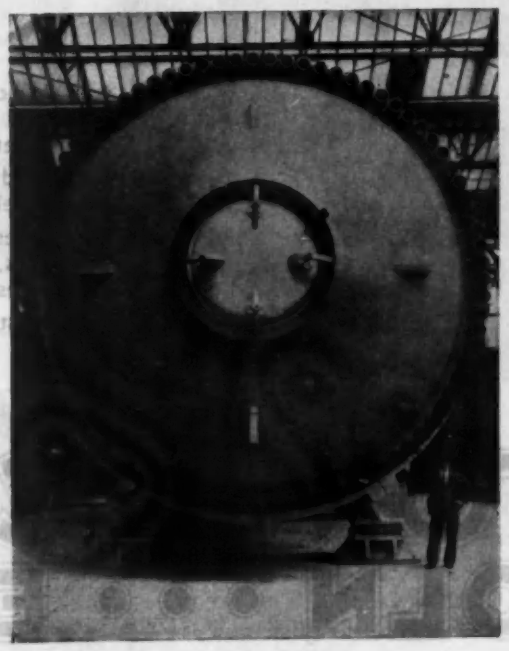

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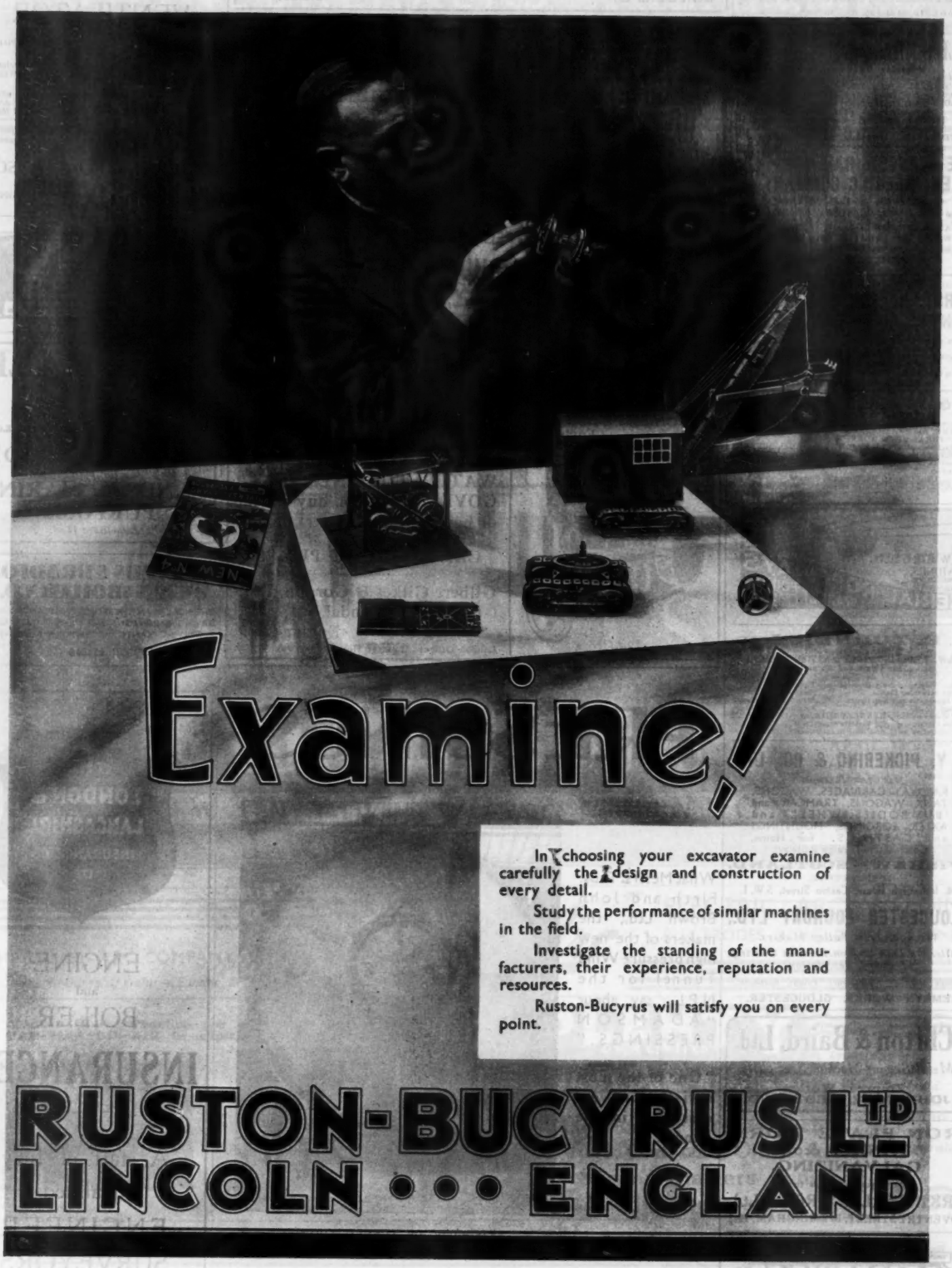
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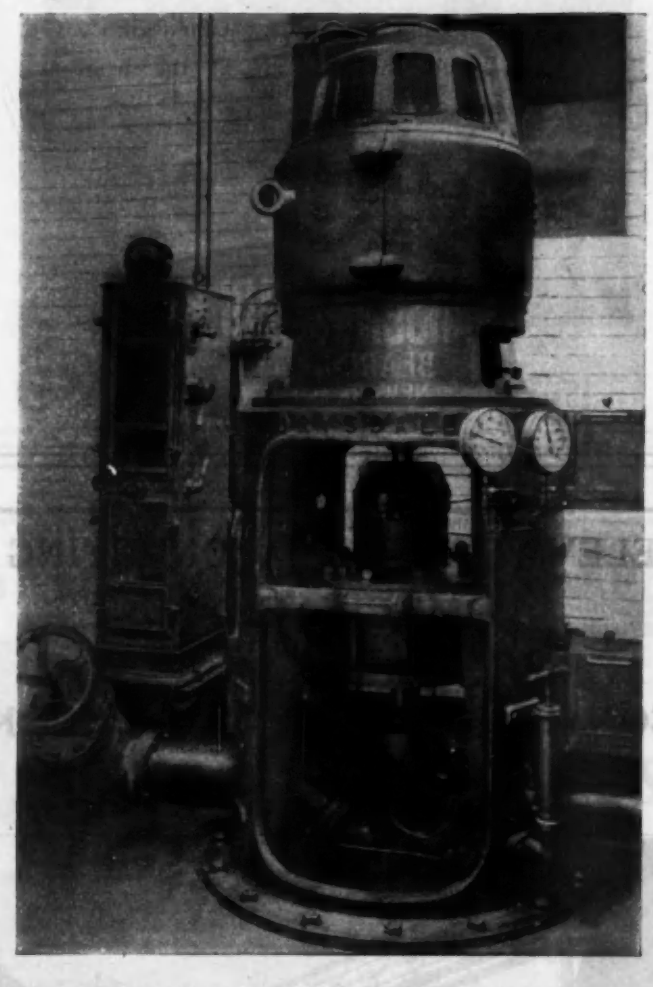

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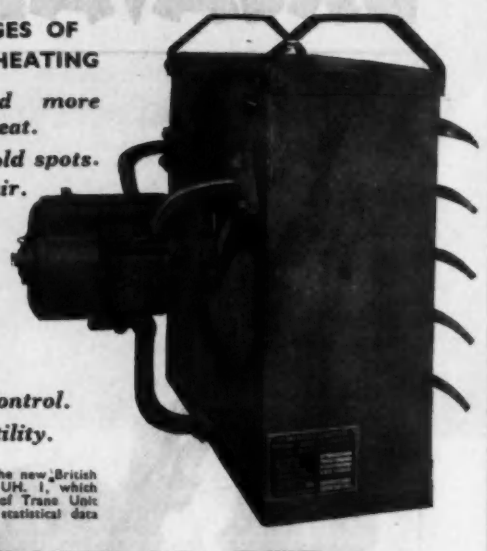

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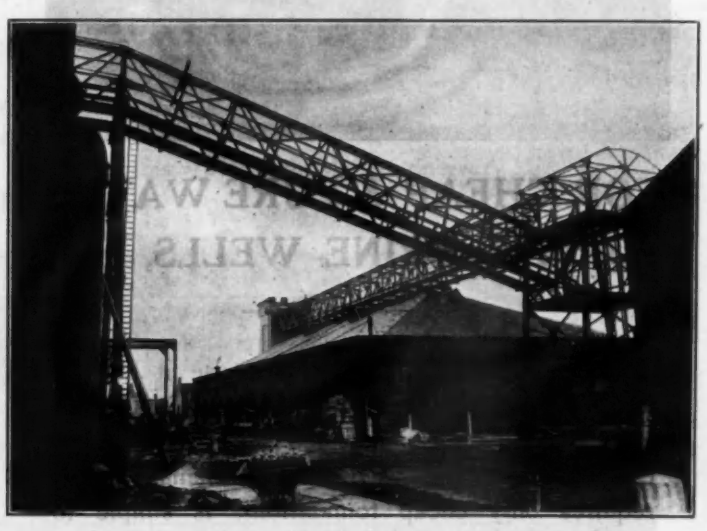

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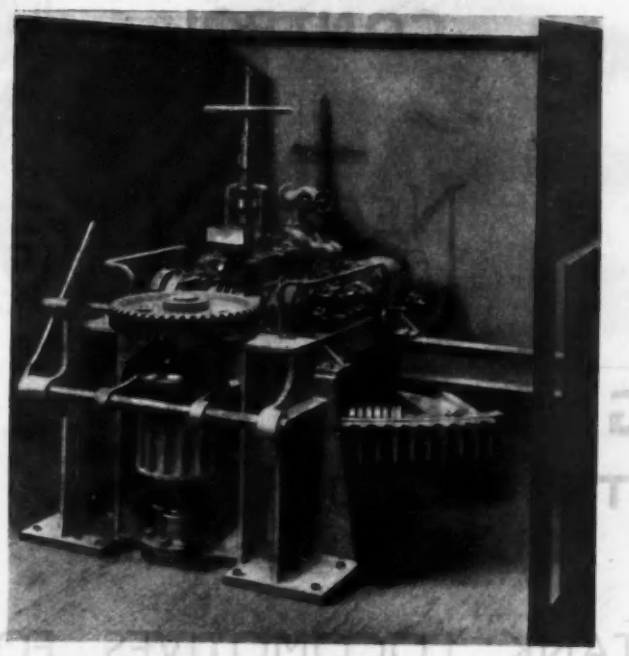

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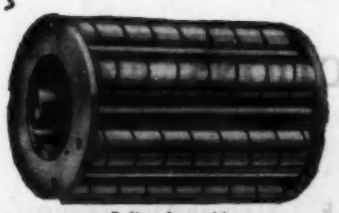
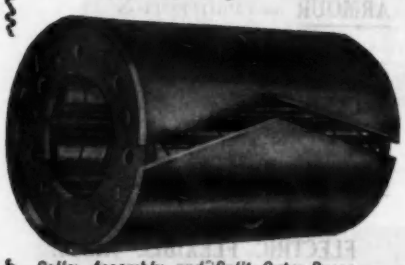


*Roller Assembly*



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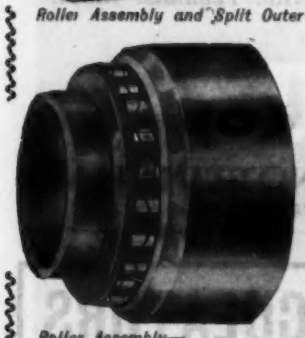
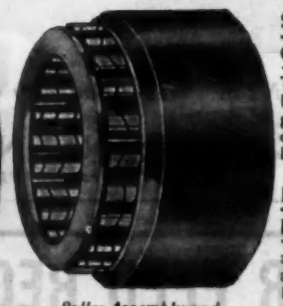


*Roller Assembly— Solid Inner and Outer Races*



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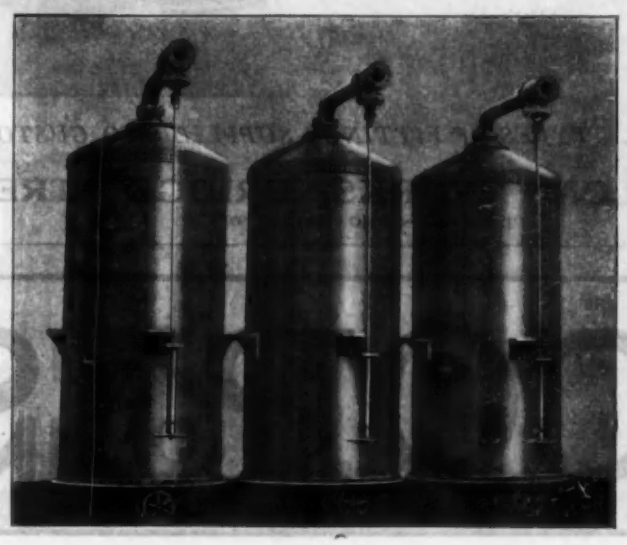

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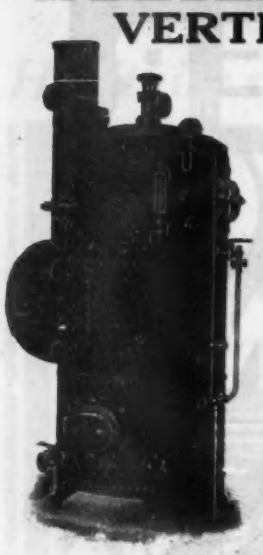

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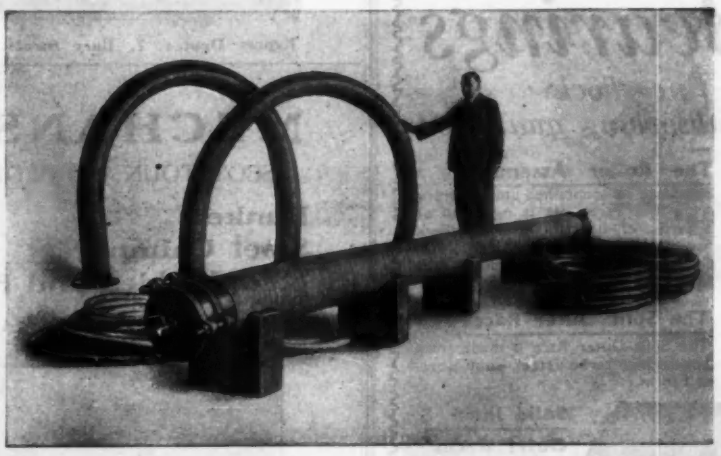

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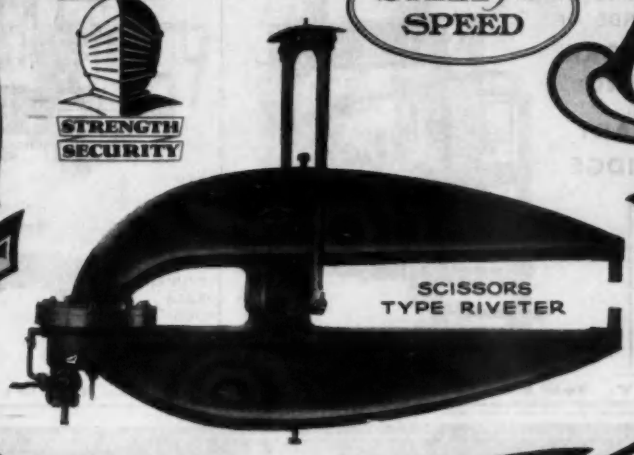


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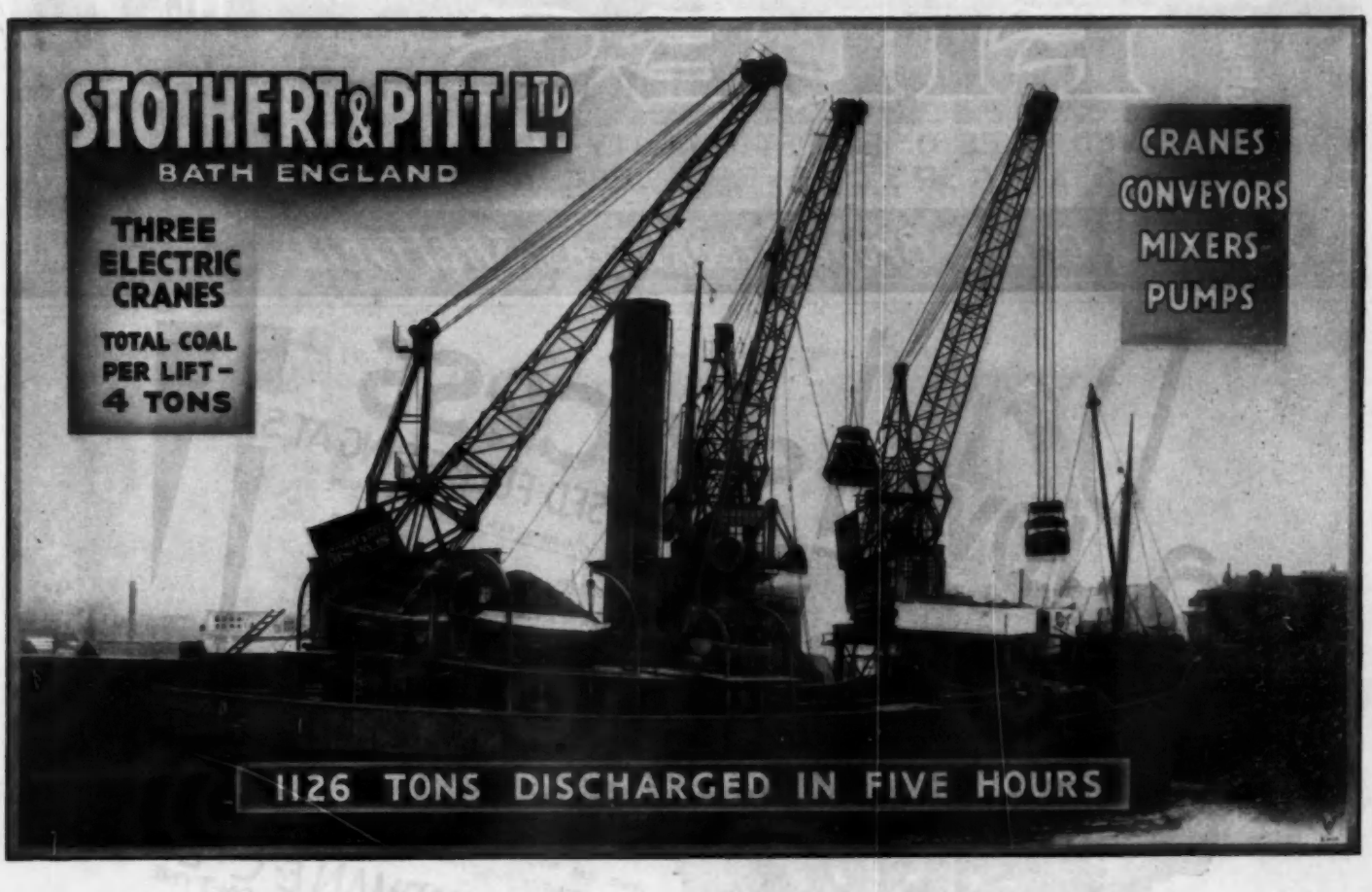

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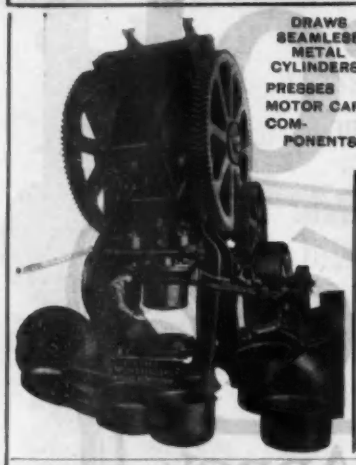

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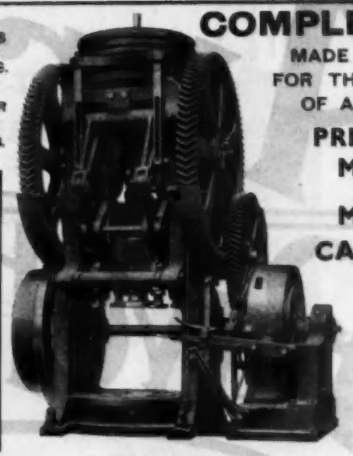

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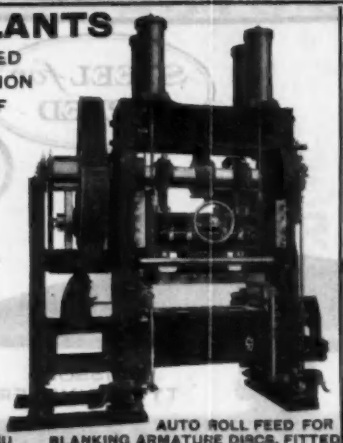

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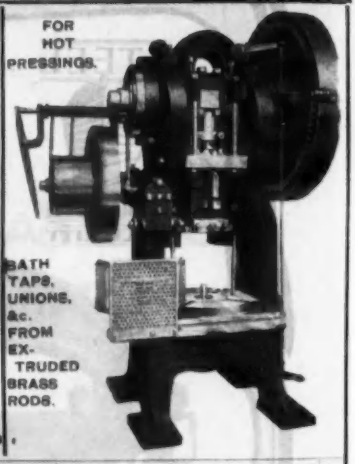

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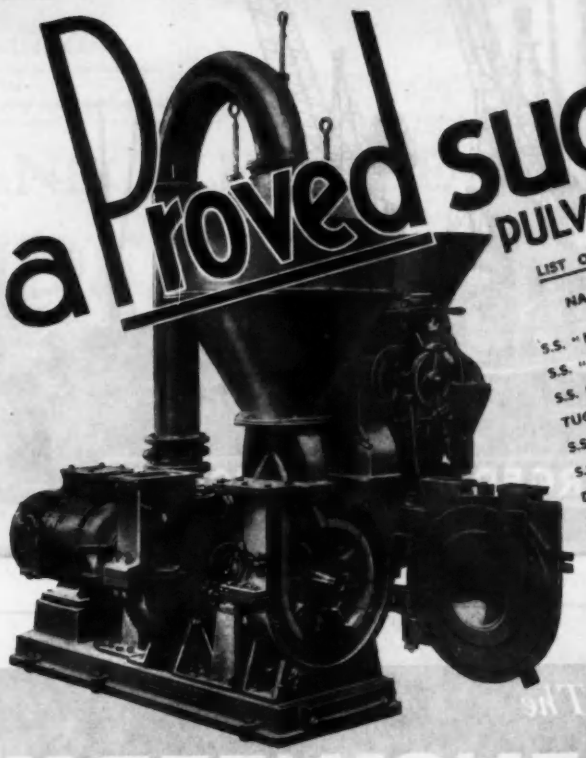

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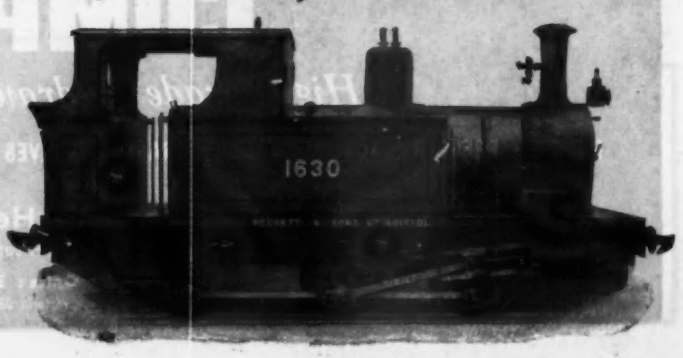


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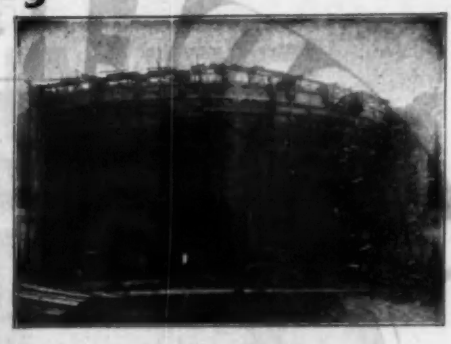

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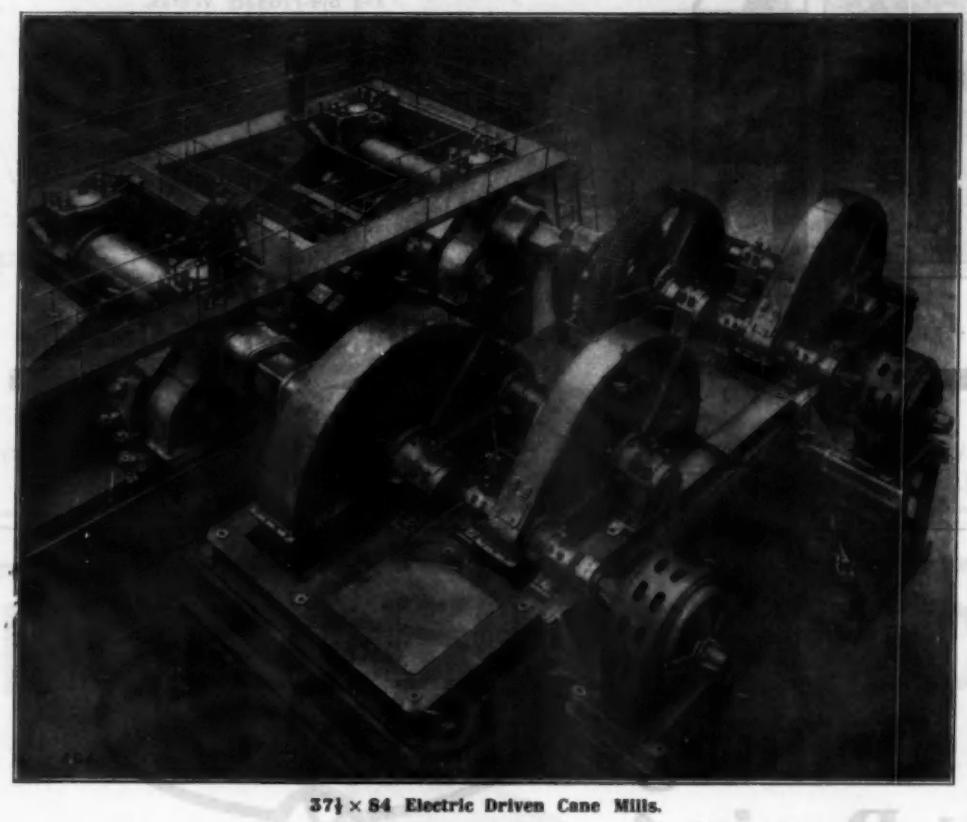

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2½" Spindle, 5' 0" × 5' 0" Travel.

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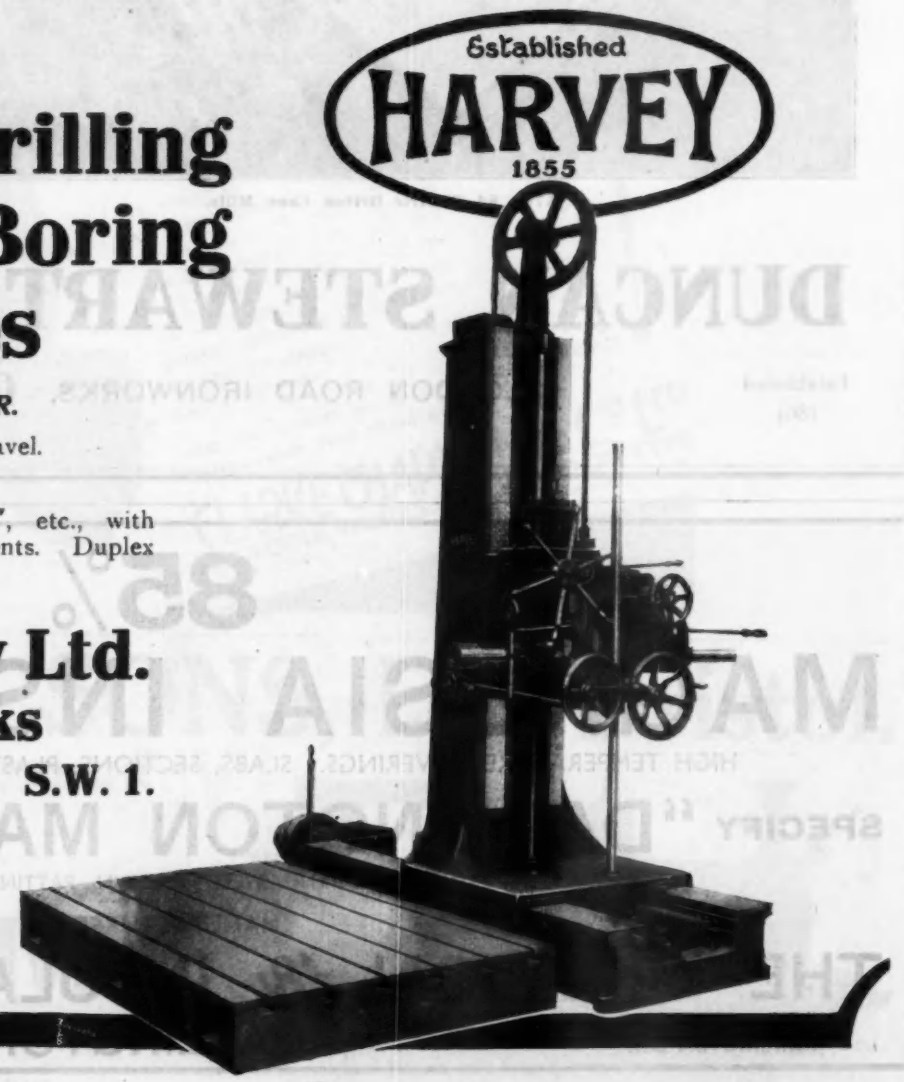


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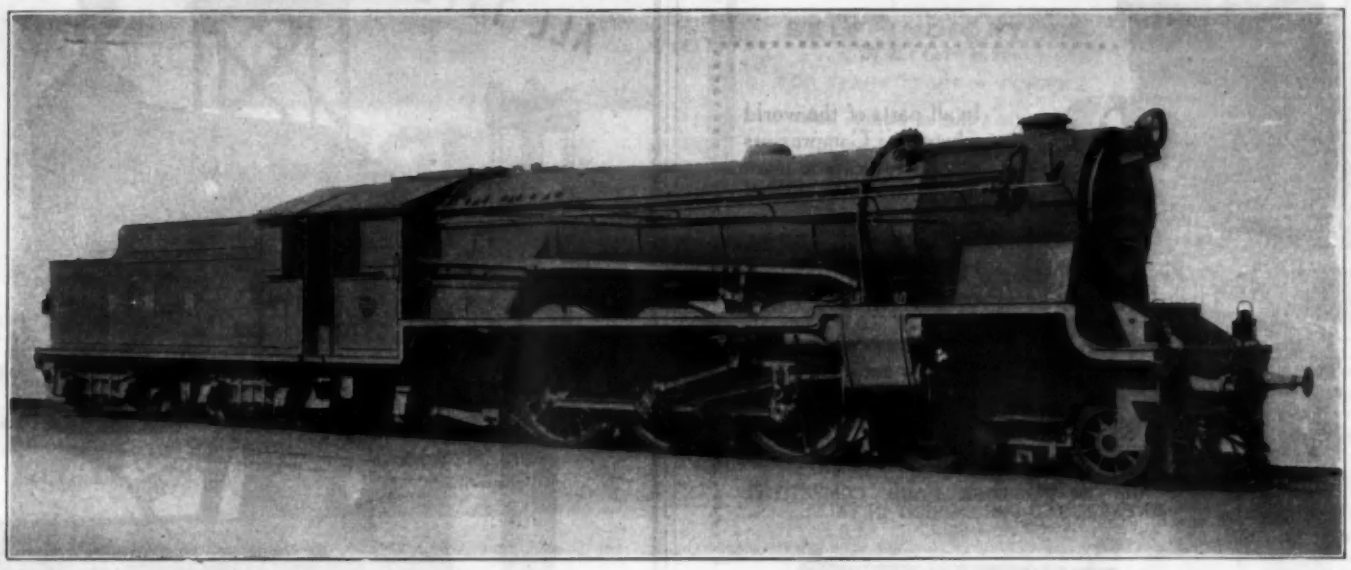

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Weight per Coupled Axle 21½ tons.
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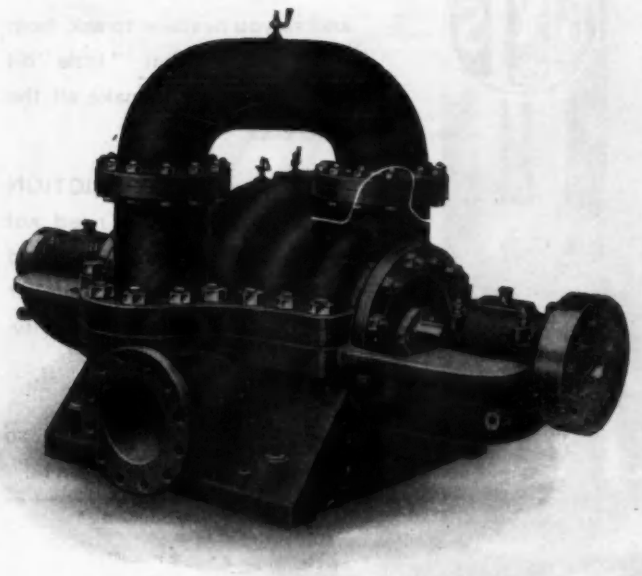

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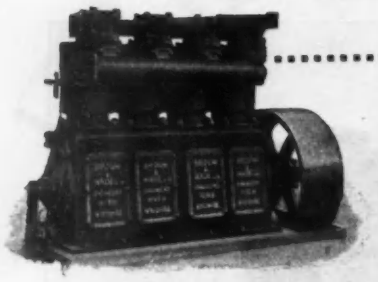

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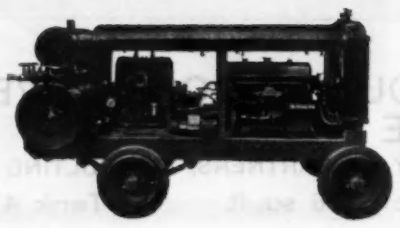

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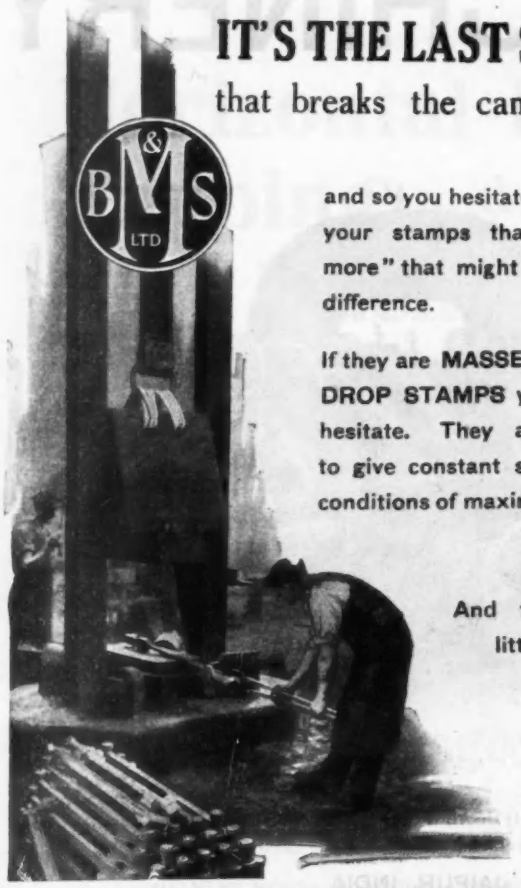


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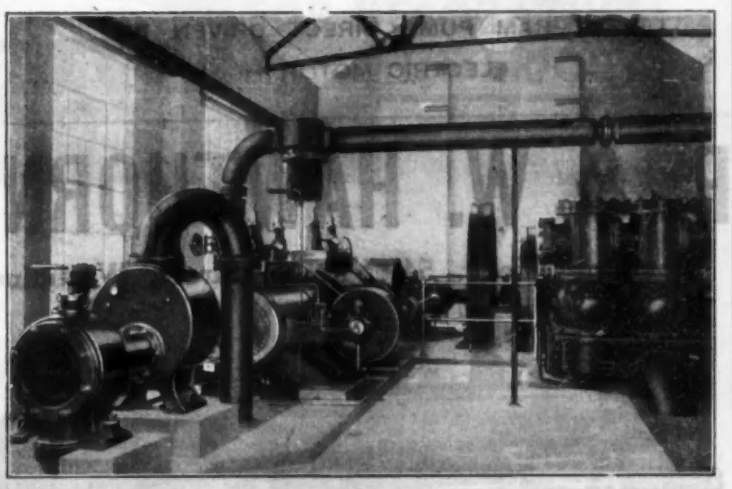

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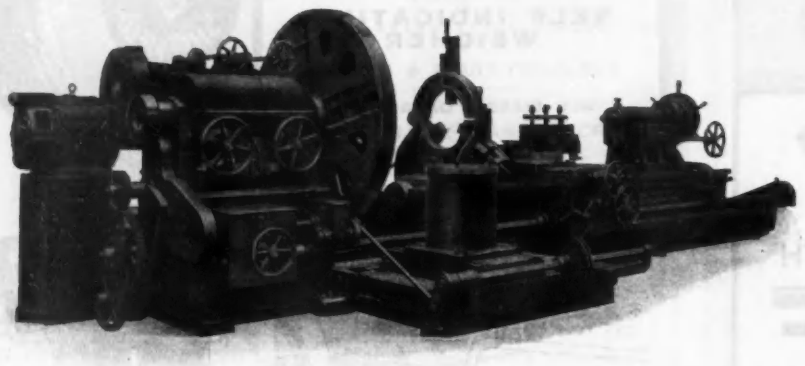

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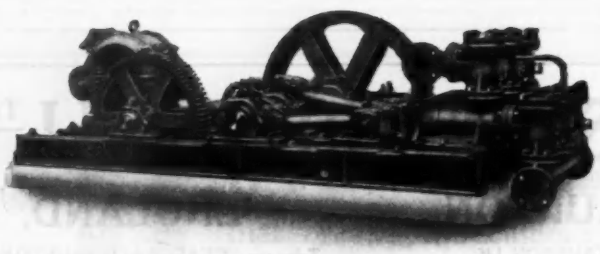

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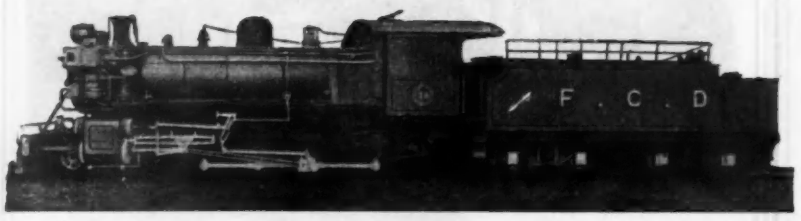


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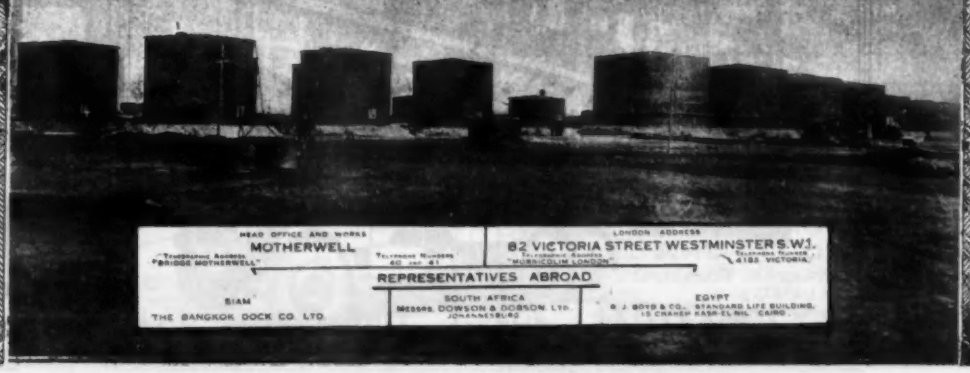

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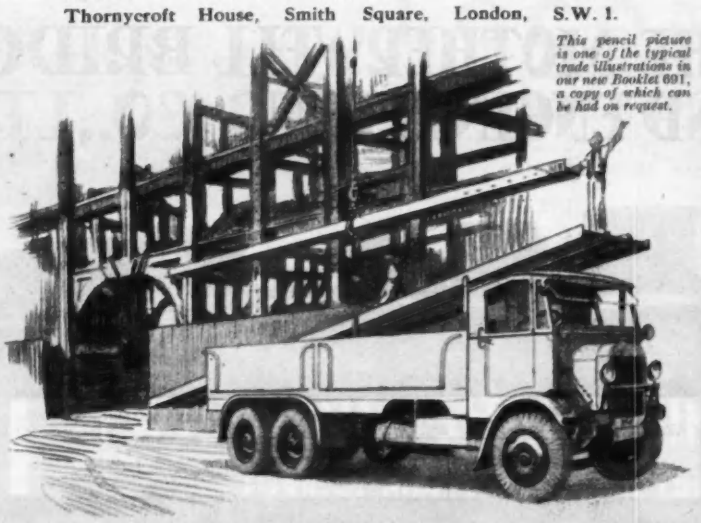

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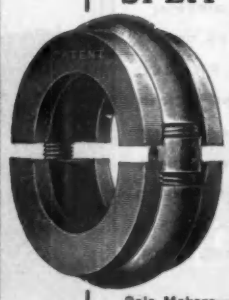

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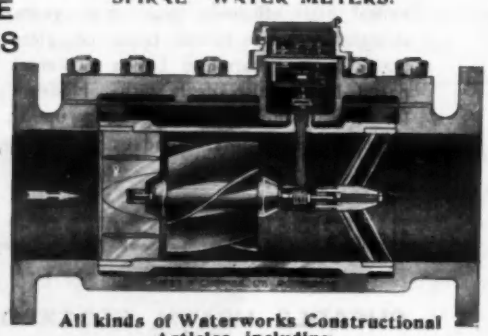

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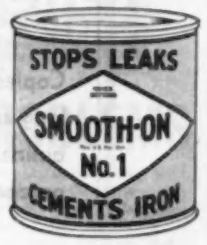


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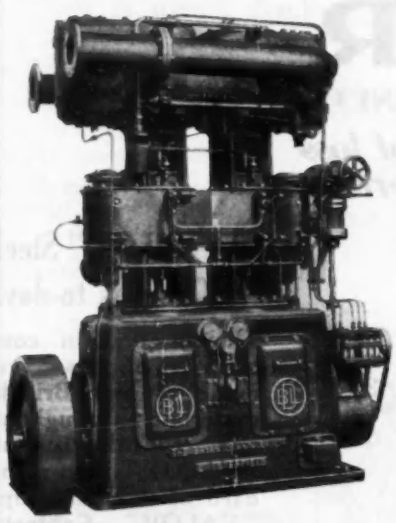

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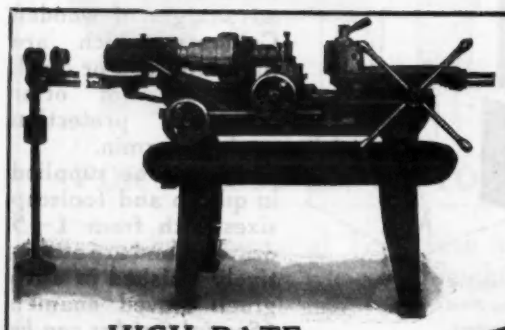

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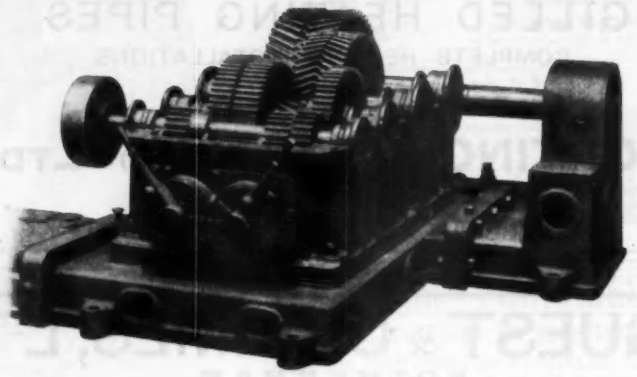

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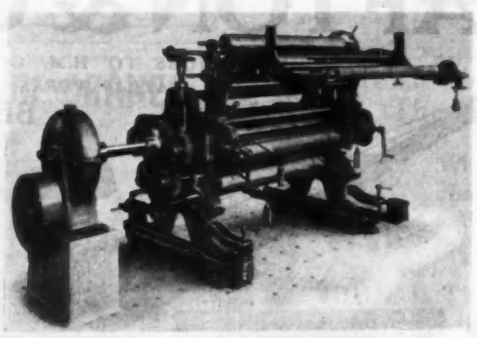

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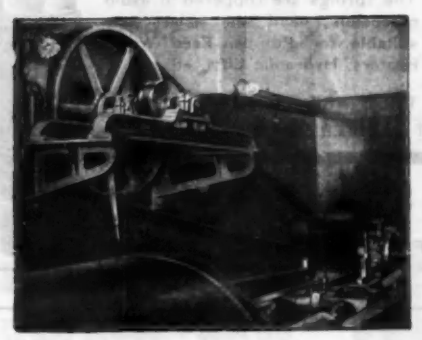

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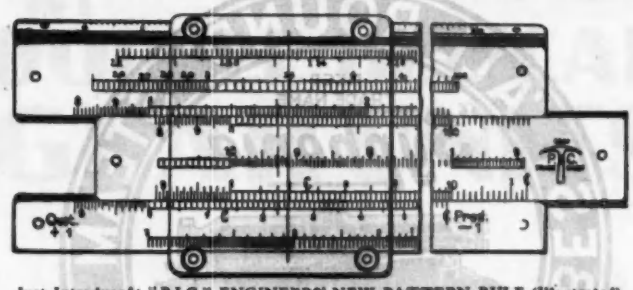

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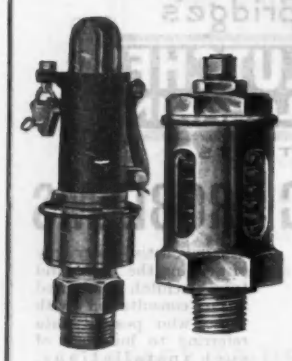

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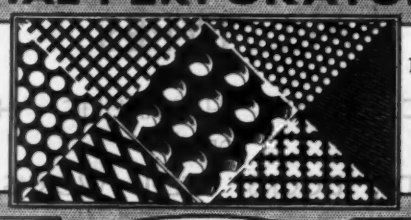

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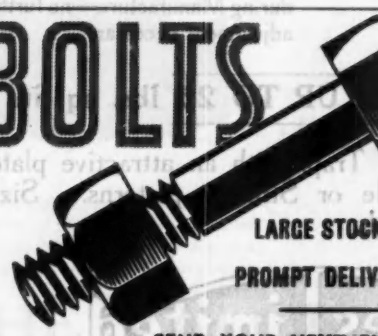

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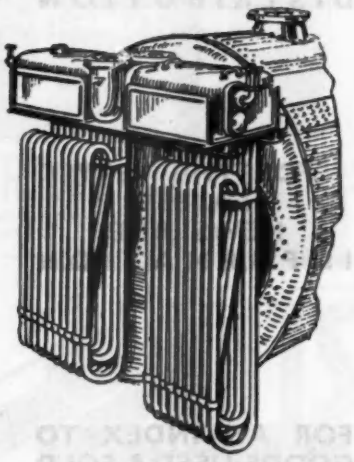

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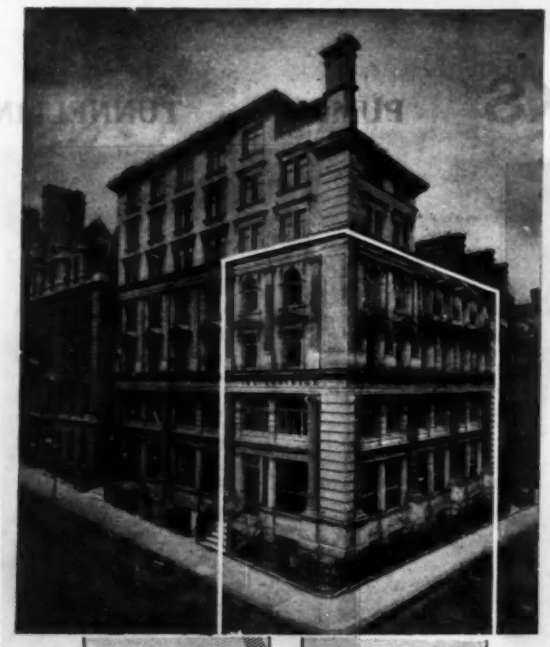

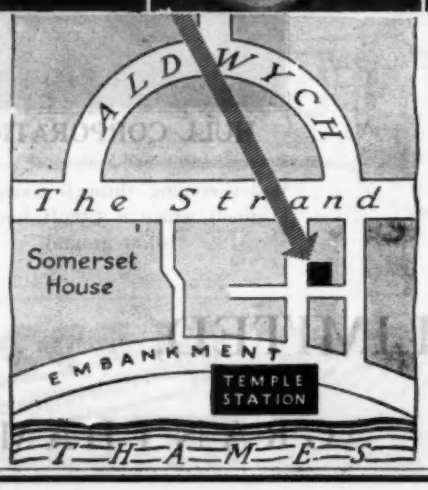


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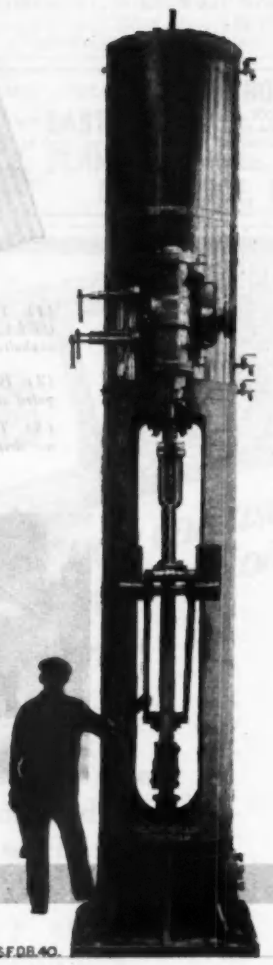

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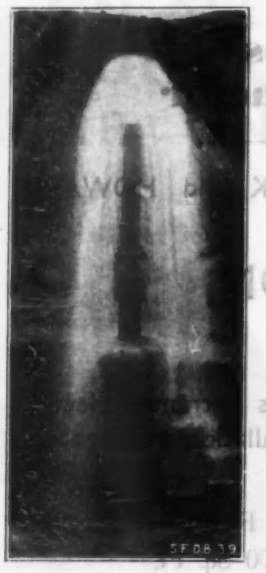

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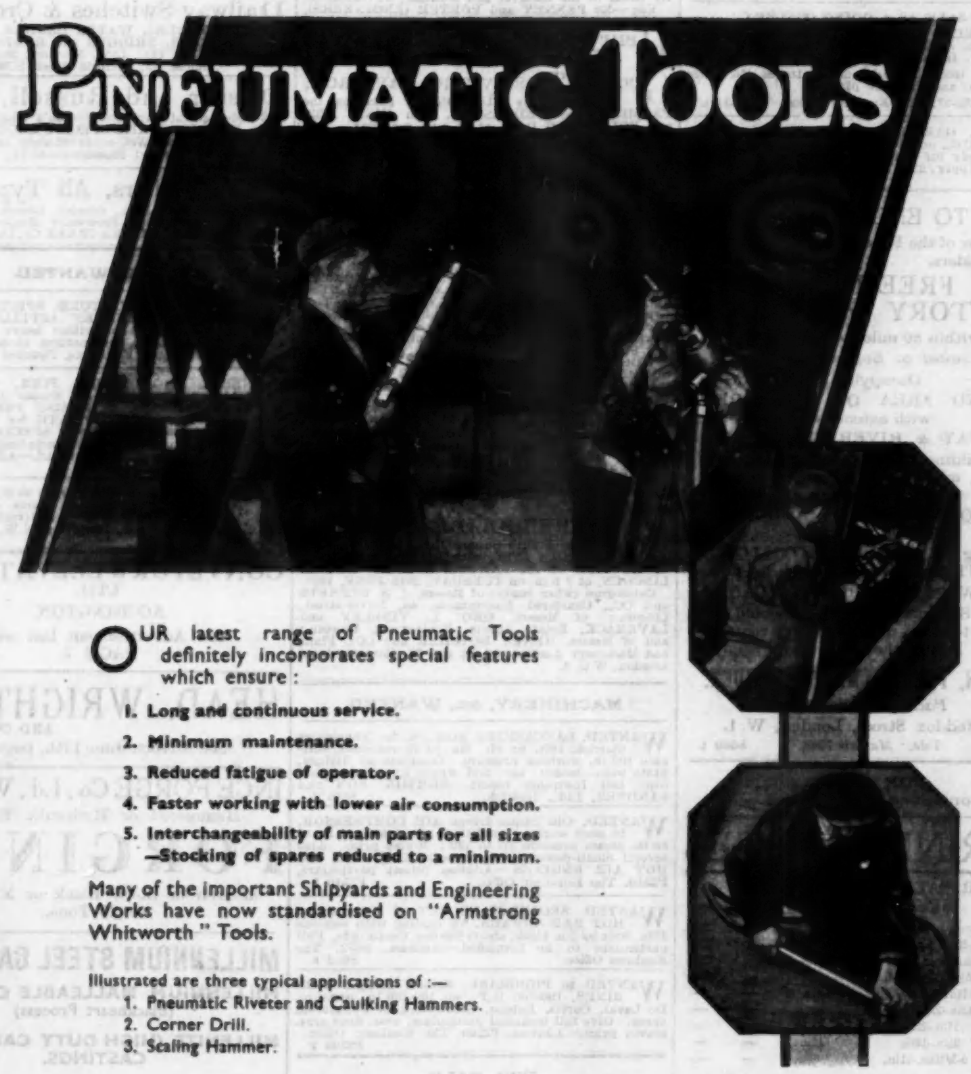

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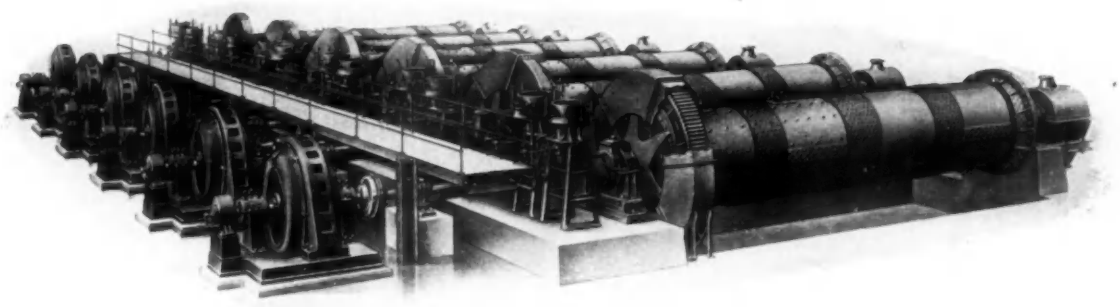

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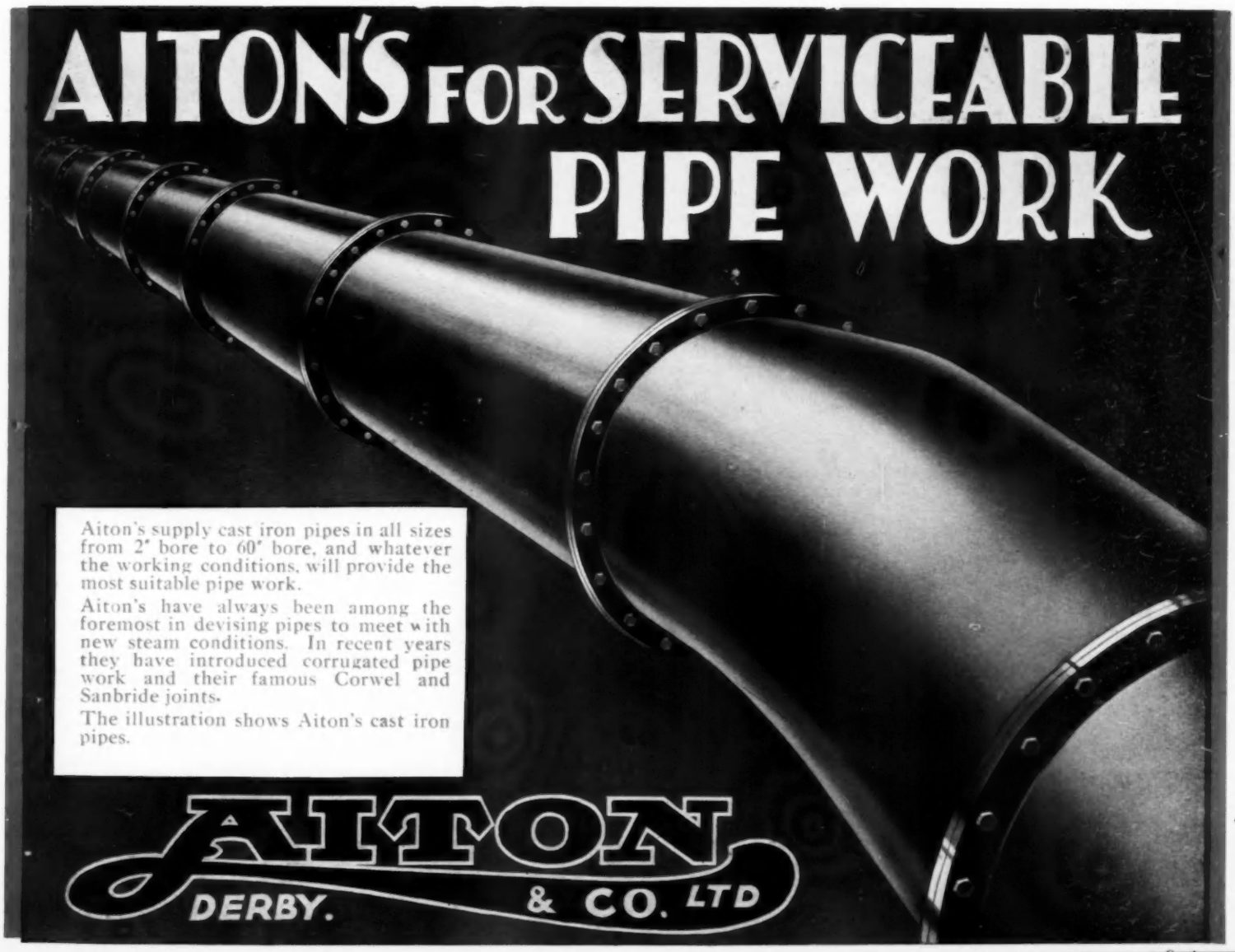

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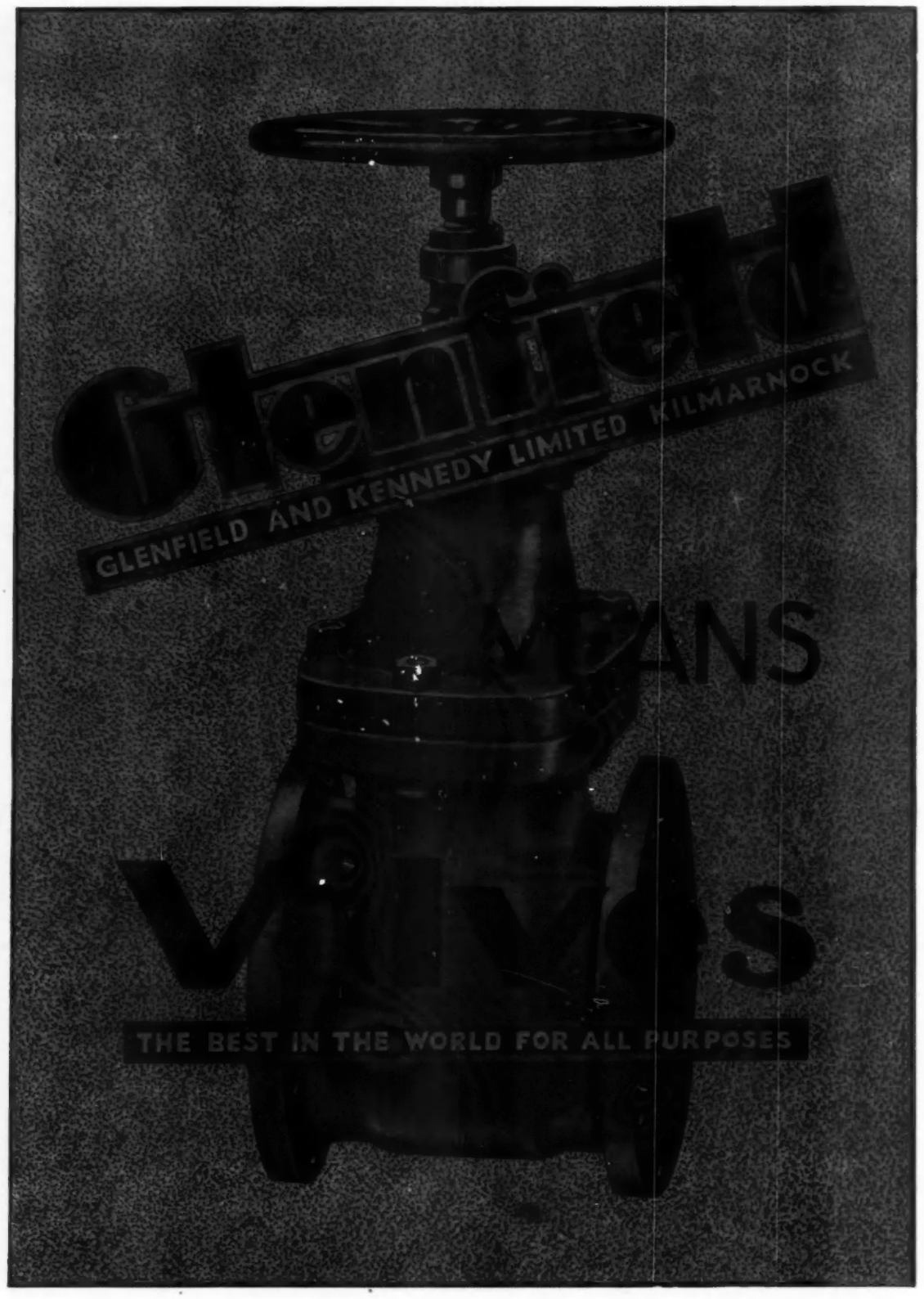


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